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P. 280, § 13, for *Natur*, read *steter*.
P. 250, 18 l. from bottom, for *Melanipyrum pedicularis*, read *Melampyrum, Pedicularis.*
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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. I.—*Biography of Berzelius;* by Prof. H. Rose of Berlin.*

On the 7th of August, in the memorable year 1848, Berzelius died at Stockholm, after long and painful suffering, in his 69th year.

Distinguished men, who, during a long and active career, have enjoyed a great reputation, may have attained their celebrity in various ways.

When a teacher draws round him by his theoretical and practical instruction, or by an overpowering force of convincing eloquence, a circle of students whom, under his animating example, he inspires with enthusiasm for his doctrines,—or when, by an extraordinary talent for illustration, he renders even the most difficult branches of science accessible to the inquiring public, or by an able combination of known facts, he opens the way to the most fruitful ideas, such a man may contribute to the general diffusion of a scientific spirit, and otherwise exercise the most beneficial influence. But if at the end of his career, we examine whether a void has been left by his removal, it will often be found that science would have preserved, upon the whole, the same boundary if he had not labored for it. It may be that his influence upon science, although considerable, has been only indirect.

On the contrary, there are other men of special endowments, possessing in a high degree the talent for research, who recognize

* Delivered at the Public Meeting of the Academie der Wissenschaften, in Berlin, on 3d July, 1851, and cited from the Edinburgh New Philosophical Journal, vol. liii, October, 1852.

with marvellous penetration where to direct their investigations, and frequently, by discovering a few apparently very simple facts, clear up our views in a surprising manner, overthrow long-established prejudices, and advance science with gigantic strides.

It is rarely that men of the latter kind follow up and complete their scientific conquests. They generally content themselves with having shewn, by their discoveries, in what direction the study of details is to be pursued, and, after having pointed out the course and the method of filling up the gaps, resign the execution of the work to others.

Such a man was Humphry Davy. There are none who will not acknowledge that at the commencement of this century, chemical science received through him, by the discovery of the metallic nature of the alkalies, a most extraordinary impulse. But, however industriously and incessantly he occupied himself for years with experiments connected with his great discoveries,—experiments which led to the development of entirely new views, and enriched in a remarkable manner many branches of the science,—still he was unable to cultivate it in its entire extent. During his unfortunately too brief career, while advancing from discovery to discovery, he had neglected to give his attention to the details of the science; and when he attempted to combine chemical facts into a system, and to publish an elementary work on chemistry, it soon became evident that he was not fully equal to this undertaking; of his "Elements of Chemical Philosophy," only the first part of the first volume appeared.

But when a man possessed of the most remarkable powers of investigation enriches all branches of his science with the most important facts, distinguishes himself equally in empirical and in speculative researches, embracing the whole in a philosophic spirit, while, at the same time, bringing the details into complete systematic order, and, lastly, occupying the lofty position of a practical and theoretical teacher of an inquiring circle of pupils, he fulfills the highest requirements of his science in such a degree as to remain in after ages a brilliant type of his class.

Such was Berzelius. It is seldom that all these qualities are found united in one man in so high a degree of perfection as they were in him. In this respect, and in chemical science at least, he has been exceeded by none.

Since the death of Berzelius several biographies of him have appeared, especially in Sweden. All tell how in his childhood and youth, he had to struggle with care and poverty,—how he gradually overcame all obstacles,—how, in spite of his unpropitious external circumstances, he opened a way for himself, and entered upon the career for which he was destined.

But in an academic eulogium, it is before all things appropriate to point out the scientific merits of the deceased, to shew how

much science has been extended by him, and how great the loss it has suffered in his death.

It was exactly at the commencement of this century that Berzelius first appeared as an independent investigator. Volta had just constructed the electrical pile which bears his name, and its astonishing effects occupied in a high degree the attention of the men of science of the time. The unexpected chemical phenomena produced by the pile excited the interest of chemists fully as much as that of physicists, and induced them to multiply experiments with this remarkable apparatus. The first investigation made public by Berzelius was upon the effects of the electrical pile upon saline solutions. In the year 1803, there appeared in *Gehlen's Neu. Allg. Journal der Chemie* an important paper on this subject, the joint production of Berzelius and Hisinger. However manifold and remarkable were the results which had hitherto been obtained with the Voltaic pile with regard to chemical decomposition, still no one had succeeded in discovering the laws of these phenomena. Berzelius was the first to find the thread which could lead with certainty through this labyrinth of complicated phenomena. He shewed that substances which are liberated at one pole, have in other respects a certain analogy; that all combustible bodies, alkalies and earths, were carried to the negative pole, and on the contrary, oxygen, acids, and highly oxydized bodies to the positive pole. But what particularly proves the admirable sagacity of Berzelius is the circumstance that he did not allow himself to be led astray by the appearance of the same body, sometimes at the positive, sometimes at the negative pole, as, for instance, the appearance in the decomposition of nitric acid, of nitrogen at the negative, in the decomposition of ammonia at the positive pole. It was, on the other hand, clear to him even at that time that the antitheses between the constituents of a chemical compound were only relative, and that one and the same body may behave as a base to a second, and as an acid to a third.

Three years after Berzelius had made public this important investigation, in 1806, Davy developed similar views in a memoir upon some effects of electricity, which has become very famous. He extended the experiments considerably, prosecuted them with very ingenious apparatus, by means of which he succeeded in disproving many erroneous views as to the effects of the electric pile, which had at that time become general. He particularly explained the peculiar and remarkable mode of the transmission of substances from one vessel into another; but in his memoir he does not make any mention of the views of Berzelius, which correspond with his own; and Pfaff, who translated Davy's paper for Gehlen's Journal, felt it necessary to remark that three years previously Berzelius and Hisinger had made known

all the fundamental principles which Davy now brought forward as entirely new.

In 1807, Davy received the prize of 3000 francs, offered by the Emperor Napoleon for the best set of experiments made during that year on the subject of galvanism. The merits of Berzelius and Hisinger were unnoticed.

After Davy had made known, in October, 1807, the important discovery of the metallic nature of the alkalies, and thus excited in a high degree the attention of scientific men, Berzelius also occupied himself with the separation of the alkaline metals by means of the voltaic pile. In the spring of 1808 he formed the happy idea at the same time with Seebeck who was then living at Jena, of employing mercury as the negative pole in the decomposition of the alkalies, which were placed at one side in contact with it in a moist state, and at the other in contact with the positive conducting wire. Berzelius made these experiments in conjunction with Pontin. In this way he succeeded in obtaining amalgams not only of potassium and sodium, but also of calcium and barium. Davy had in vain attempted to exhibit the metals of the alkaline earths by the methods which had fortunately yielded him the metals of the fixed alkalies: he could only obtain barium, strontium, and calcium, from amalgams prepared according to the method communicated to him by Berzelius.

But the most surprising results were those which Berzelius obtained in decomposing ammonia by the voltaic pile, likewise employing mercury as the negative pole. He obtained the ammoniacal amalgam, respecting the nature of which he even then entertained correct views. He had employed in this experiment caustic ammonia, while Seebeck, at the same time, and in a manner quite similar, obtained the amalgam with moistened carbonate of ammonia. Tromsdorf also, in conjunction with Göttling, obtained this amalgam at about the same time as Seebeck.

While Berzelius thus occupied himself at the commencement of his scientific career in experimenting with the voltaic pile, he was also led to form a theory of this pile in some respects at variance with that of its famous discoverer. Volta, in constructing his theory, had not taken into account the chemical activity of the pile, regarding that merely as an effect, and not as the cause of electrical action. Berzelius as a chemist put forward the opposite view, that the electricity of the pile results from the chemical action of the moist conductor and the positive metal. This chemical theory of the pile found great support, and it is still entertained by many distinguished physicists, and among them even by Faraday. Berzelius, however, unbiassed by prejudice, candidly returned again to the original view of Volta, after having convinced himself of its accuracy by a lengthened series of experiments. Long previously to the introduction of the

batteries of Daniell and Grove, he had constructed one of zinc, copper, and two liquids, in such a manner that the zinc was not attacked by the liquid in contact with it, while the copper was briskly oxydized by the other. If now the oxydation of one of the metals were the cause of the electricity, the copper would have been positive, and the zinc negative; consequently the poles of the pile would be reversed. Before the circuit was closed, the copper was violently oxydized and dissolved; but, when the poles were connected, this action ceased immediately, and metallic copper was precipitated from the liquid upon the copper plate. This experiment rendered it obvious to Berzelius that chemical activity could not be the cause of the electrical phenomena; for the former ceased when the poles were connected, and the direction of the current was that indicated by the principle of contact-electricity. These experiments were instituted by Berzelius before many physicists had commenced to adopt the chemical theory of the pile, and especially long before Fechner endeavored to prove the truth of the contact theory by his ingenious experiments.

It was not, however, these experiments with the voltaic pile which alone, or even principally, occupied the attention of Berzelius at the commencement of his career. At the instigation of Hisinger, who had a particular partiality for the chemical part of mineralogy, and to whom, as a geologist and mineralogist, Sweden owes so much, Berzelius early directed his attention to the quantitative analysis of minerals. He candidly admitted in after years, that in the first instance, when the law of combination in simple definite proportions was not yet established, he did this chiefly on Hisinger's account. But the very first result of an investigation of this kind, carried on in conjunction with Hisinger, was of the most brilliant kind: it was the discovery of a new metal, Cerium, during the year 1803, in the so-called tungsten of Bastnäs, near Riddarhyttan in Westmanland.

It must be admitted that the discovery of a new metal is often the result of mere chance. But it is not every chemist who is able, even when greatly favored by chance, to recognize in a substance obtained in the course of an investigation, a hitherto unknown element. This requires a perfect knowledge of the known elements such as can be acquired only by many laborious investigations and long experience. For this reason new elementary bodies are not easily discovered by young chemists, not even by those of high talent. The discovery of cerium, which Berzelius made in his twenty-third year, shows therefore the great and rare sagacity which he displayed even in his first investigations.

Klaproth investigated the tungsten of Bastnäs simultaneously with Berzelius and Hisinger, and declared that the oxyd which

it contained in combination with silica was new. But he overlooked its metallic nature, and although he obtained it of a reddish-yellow color, regarded it as an earth, which he called Ochroit earth. The investigation of Berzelius and Hisinger was evidently carried out with more precaution than that of Klaproth. Not only did the latter overlook the partial solubility of the oxyd in solutions of alkaline carbonates, he did not even remark the disengagement of chlorine on treating the ignited oxyd with hydrochloric acid. It was not until afterwards, when, for the second time, he made known his investigations upon cerite in the fourth volume of his "Beiträge zur chemischen Kenntniss der Mineralkörper," which did not appear until 1807, that he mentioned the evolution of oxy-muriatic gas on treating the ignited oxyd with muriatic acid, still, however, without attaching to the fact any great weight. Berzelius and Hisinger, on the contrary, justly considered this of very special importance, as unequivocally pointing out two very different stages of oxydation, at that time one of the principal means of distinguishing between metallic oxyds and earths, which were then regarded as simple bodies. Gehlen also directed attention to this point in a remark upon the paper of Berzelius and Hisinger. Further, he was fortunate enough to accomplish, with the aid of Hjelm, the reduction of the oxyd, and to obtain the metal in an isolated, although not in a melted state.

When Berzelius subsequently undertook the determination of the equivalent weights of almost all the elementary bodies by means of a long series of experiments, he resigned the estimation of the equivalent of cerium to Hisinger, and did not occupy himself more specially with this metal. Thus probably the discovery of the oxyds of two other metals, accomplished by Mosander, thirty-six years after that of cerium, escaped him.

Besides the examination of cerite, Berzelius undertook at that time the investigation of other new and interesting minerals. But during the first period of his scientific activity he was chiefly occupied in an entirely different branch of chemistry. Berzelius's first avocation in the world, by which, poor as he was, he had to earn his livelihood, was that of physician. He naturally sought in this profession for those occupations especially in which sound chemical knowledge was indispensable. Thus he examined several of the natural mineral waters of Sweden, and these investigations, although inferior to those of a similar nature which he subsequently carried out, especially that of the Carlsbad water, still in every respect belong to the best of their time. In consequence of these investigations he established in Stockholm a manufactory for preparing these waters artificially.

But it was quite natural that as physician he should be induced to take up the study of animal chemistry. What he achieved in

this branch of chemistry, and indeed within a short space of time, is extraordinary, and opened as it were an entirely new field in this science.

Before Berzelius's time, animal chemistry was treated nearly in the same manner as that of inorganic bodies; the constituents of the animal body were arranged in certain classes, and described merely as objects of chemical decomposition, perhaps with a few general remarks as to their functions in animal life. This mode of treatment is, in a scientific point of view, totally valueless. Berzelius endeavored to combine anatomical with chemical investigations, so as to tend to a common end, in order in this to give to experiments a higher scientific connection, and to direct the attention of the chemist to the physiological aspect of the subject.

In this spirit he investigated almost all parts of the animal body, solids and fluids, certainly only qualitatively, as at the commencement of this century there did not exist the most remote knowledge of those methods for the quantitative elementary analysis of organic substances, which have only been subsequently brought to a high state of perfection, especially by the labors of Berzelius himself, and afterwards by those of Liebig. But the investigations in animal chemistry carried out at that time by Berzelius, remain as examples for imitation at the present day, and have never been excelled. It is scarcely credible how much the very accurate results of his investigations differ from those which were obtained at the same time by other chemists, and solely because their investigations were undertaken from a one-sided point of view, and without any high scientific purpose. Beside Berzelius, the only chemist of that time who entered upon these investigations from a physiological point of view, was Fourcroy; but his results vary the most widely from those of Berzelius, since from scattered, uncertain, superficial, and often wholly incorrect observations, he drew general and extended inferences, although certainly in a very ingenious manner, and by his attractive illustration led the way to the greatest errors. In order to recognize the high superiority of Berzelius over Fourcroy in this respect, it is only necessary to compare the investigations of the latter upon blood, especially its red coloring matter, with that instituted by Berzelius on the same subject only a short time afterwards.

Berzelius made known his investigations in animal chemistry in the form of lectures, the first of which appeared in 1806; the second in 1808. Besides this, the most important examinations of separate animal substances appeared in the *Afhandlingar i Fysik, Kemi och Mineralogi*, and in Gehlen's Journal. He gave a masterly review of his labors in animal chemistry, compared with what was previously known on the subject, in a speech de-

livered upon the occasion of his vacating the presidentship of the Stockholm Academy of Sciences. It is there the custom annually to select from among the members of the Academy, a new president, who, in vacating his office, must deliver a scientific dissertation, which is printed. This is, indeed, frequently the only means of compelling members to publish their researches.

Within the first period of Berzelius's scientific activity, two other investigations were carried out, which for that time were of the greatest importance. They were on the reduction of silica, and the composition of cast iron.

Although Berzelius had succeeded in obtaining the metals of the alkaline earths in combination with mercury, by means of the voltaic pile, he was unable to separate in a similar manner the radical of silica from its oxygen. In order, however, to satisfy himself that silica had a composition similar to the earths, he instituted a series of interesting experiments for the purpose of uniting the radical of silica with metals, especially iron, by mixing iron filings with carbon and silica, and exposing the whole to an intense heat, by means of which he obtained reguli which contained, together with silicium, carbon. He then found approximately the quantity of oxygen present in silica, by estimating the quantity of iron and carbon, the latter certainly by a somewhat unsafe method. The remark which he makes at the close of his paper, published in 1810, is well worthy of notice. After having described his numerous experiments on the quantity of oxygen in silica, which throughout had not given very closely corresponding results, he concludes with these words: "I consider it moreover as unimportant to determine with precision the per-centage of oxygen or radical in silica, since I am unable at the present time to perceive either theoretical or practical advantage to be gained by this accuracy." A few years later he would not have expressed himself in this manner.

Another investigation important for this period related to the composition of crude iron. At the commencement of the present century, singular ideas of its composition had been formed. It was supposed that oxygen generally existed in iron associated with carbon; and, indeed, an Essay, in which the quantity of oxygen in crude iron was supposed to have been demonstrated, obtained a prize. This view was principally founded upon the circumstance, that on treating crude iron with non-oxydizing acids, less hydrogen was obtained than with an equal weight of malleable iron. Berzelius proved that in this case an oleaginous hydrocarbon was produced, and shewed, with the greatest certainty, that there could not possibly be any oxygen in crude iron. He determined the quantity of carbon by converting it into carbonic acid. Subsequently he attempted to estimate the carbon directly, by dissolving the iron through the agency of chlorid of

silver or chlorid of copper. At that time attention had not been directed to the difference between the chemically combined and the mechanically intermixed carbon or graphite. This was not recognized until subsequently by Karsten, who also proved that graphite consisted of carbon alone, and contained no iron. While prosecuting the analysis of crude iron, Berzelius made several interesting observations; thus, besides others, he was led to propose the use of benzoic acid as a means of separating peroxyd of iron from protoxyd of manganese and magnesia, instead of the then more costly succinic acid recommended by Gehlen. He further showed, that on treating crude iron with nitric acid, an extractive substance, having an almost perfect resemblance to the extract of vegetable mould, is produced from the carbon of the iron. He also accidentally discovered during this analysis the interesting double salt of persulphate of iron and sulphate of ammonia, the composition of which he was the first to determine qualitatively with accuracy. This salt he at first regarded as alum, on account of the form, though he found no alumina in it. He moreover pointed out that the silica which he obtained after the solution of the iron did not exist in the crude iron as such, but as silicium. However important the various facts ascertained during this investigation might be, Berzelius was still not fully satisfied with the results obtained, since he could not rely upon the correctness of the method which he had employed for the quantitative determination of carbon or of magnesia, whose presence in the solution of crude iron he had proved. On this account, he published his investigation under the modest title of *Attempt to Analyze Crude Iron.*

I now come to the most important period of Berzelius's scientific activity. His previous achievements were owing more to circumstances than to any leading ideas. He was, to a certain extent, incited by the scientific interest of the time to take up the galvanic investigations, by the friendly intercourse with Hisinger to enter on the chemico-mineralogical, and, finally, by his professional position to engage in those on animal chemistry. Towards the end of the first decennium, however, he was led, especially by the investigations of Davy, to study the simple chemical proportions in which bodies generally combine with each other, and from this time applied all his energies to this subject. The activity which he now developed, under the guiding influence of a great idea, was in fact gigantic; for, after the lapse of only a few years, he established, to the amazement of his contemporaries, the complete theory of combining proportions, a subject the details of which he labored constantly in perfecting and improving during the remainder of his life. It may be safely affirmed, that it was only from this time that chemistry became in truth one of the exact sciences; for from the collection of em-

pirical facts which had hitherto borne the name of chemistry, the universal law now first developed itself, according to which bodies enter into chemical combination.

Berzelius is not, properly speaking, the first discoverer of the doctrine of chemical proportions. It generally happens in all sciences that great laws are not suddenly discovered by one investigator, but are gradually recognized.*

* * * * * * *

During the previous century chemists who had occupied themselves with the phenomena of the so-called chemical affinity, made several observations which incontrovertibly proved that there was a strict uniformity and order in the chemical combinations of bodies. These men were especially Bergmann in Sweden, Kirwan in Dublin, Wenzel in Dresden, and above all, Richter in Berlin. The latter two had indeed come to the conclusion, that acids and alkaline bodies must combine in definite proportions, because in the double decomposition of neutral salts neutral products are formed.

But when it was attempted to prove this preconceived law by demonstrating the composition of the decomposed salts, the proofs brought forward were either altogether insufficient or very incomplete,—a circumstance resulting from the then imperfect methods of separation, by means of which it was impossible to attain to such accurate analyses that the calculated results of the decomposition of two neutral salts could correspond with experiment.

The attention of chemists was soon diverted from this subject when in the eightieth year of the past century the theories of Lavoisier gave a new direction to the whole science. The attack upon the phlogistic theory, and the establishment of the antiphlogistic system, took undivided possession of all thinking minds. None had time to occupy themselves with any other than the qualitative changes which bodies underwent by their mutual decomposition. It was also necessary that Lavoisier's theory should have gained a complete ascendency before the doctrine of simple chemical proportions could be fully recognized and appreciated.

In addition to this the development by Berthollet, one of the most gifted chemists of the time, of a theory apparently in total opposition to that of definite chemical proportions, tended to withdraw attention from the latter. Berthollet endeavored to prove, that bodies which possess an affinity for each other are capable of combining in all proportions between certain maximum and minimum quantities, and that when the combination took place in definite proportions this was owing to special circum-

* Owing to the indistinctness of the MS., a long sentence, is here omitted. The want of it, however, does not affect the sense of the text.

stances, particularly the power of crystallizing or of cohering in any form, in consequence of which compounds could separate from a solution, as precipitates or crystals; or else owing to the expansion taking place on passing into the gaseous state, by which they removed themselves from the sphere of action of solid or fluid bodies. The most important law established by Berthollet was, however, that of the so-called chemical mass, according to which the deficiency of a body in chemical affinity may be replaced or compensated for by increasing its quantity: and it is indisputable that this law, although it has latterly been more and more forgotten, is perfectly correct.

The first of these principles, established by Berthollet, viz: that all chemical combinations are possible between a certain maximum and minimum, and in indefinite proportions, was immediately disputed by Proust, who endeavored, by means of many ingenious experiments, to shew that every chemical combination takes place in definite proportions, and that between it and the nearest allied combination there is a certain interval within which there is no intermediate stage.

Berthollet's views were at that time apparently supported by the numerous erroneous representations of the composition of the most important compounds. Likewise the experiments which he made, or caused to be instituted, in order to disprove the assertions of Proust were far from being adequate. Proust's experiments were certainly in most cases more correct, although not in such a degree as to place his views beyond all doubt.

Sometime after the analogy in composition between the alkalies and metallic oxyds was proved by Davy's important discovery, the attention of Berzelius was also drawn to the quantitative relations in which bodies combined with each other. It was the chemical nature of ammonia, which, in the first instance led him to enter upon this gigantic investigation. After the discovery of oxygen in the alkalies, the conjecture that all saline bases, and consequently ammonia, contained this element, was not unnatural. This view received a still greater probability by the discovery of the ammoniacal amalgam.

Berzelius now commenced a series of investigations for the purpose of determining the quantity of oxygen in alkalies and earths, by oxydizing with water the basic metal in a weighed quantity of the amalgams which he first learned how to prepare, then combining the oxyd produced with hydrochloric acid, and in accordance with the then received views of the composition of chlorids, found the quantity of acid in the salt, and by the loss the quantity of oxygen in the base itself.

On subjecting ammonia to the same process he was not able either to isolate the ammoniacal metal, or to combine it with the mercury in such a quantity as to obtain a result. He then en-

deavored to attain his purpose by the direct determination of the oxygen supposed to exist in ammonia. He wished to make an application of the discovery made by Bergmann in his work "De diversa phlogisti quantitate in metallis," that when one metal separates another in a metallic state, from solution in an acid, the metal suffering solution yields precisely the same amount of phlogiston as the one previously dissolved requires in order to assume the metallic form; that a certain acid in dissolving metals expels equal quantities of phlogiston from the different metals; or to express the same in the language of the antiphlogistic system, that when a certain quantity of any acid combines with different metallic oxyds, forming neutral salts, the oxyds must contain an equal and invariable quantity of oxygen.

But in order to be able to apply this law of Bergmann with perfect certainty, unassailable proofs of its perfect accuracy were necessary. Those which Richter had given could not be regarded as at all admissible. Berzelius now compared his analyses of potash, soda, and lime with Bucholz's analysis of oxyd of silver, and that made by my father of oxyd of mercury; and he found in fact that the quantity of these bases which saturate the same quantity of hydrochloric acid, forming a neutral salt, contained, with very slight deviations, the same quantity of oxygen. But when he came to examine other metallic oxyds and combinations with muriatic acids, the results obtained were so much at variance (perhaps on account of many erroneous premises which he assumed) with the principle of Bergmann, that he was compelled to ascribe the want of correspondence either to his own want of dexterity in experimenting, or to an erroneous application of Bergmann's laws. Since, however, careful repetition of his experiments gave results corresponding closely with those first obtained, he began to entertain doubts of the correctness of Bergmann's law. When, again, he subsequently found that metallic sulphurets, on being perfectly oxydized by nitric acid, yielded neutral sulphates of the oxyd, without any excess either of metallic oxyd or sulphuric acid, he felt compelled to return again to the opinion which he had abandoned. At the same time he observed that metals unite with double (exactly or very nearly) as much sulphur as oxygen, and that by a simple rule of three, the capacity of combination of any metal for sulphur may be calculated from its oxyd, or the contrary. He was now again led to study the mutual decomposition of neutral salts, and he finally succeeded in practically demonstrating, from the composition of several salts, the neutrality of those resulting from their decomposition.

I feel myself justified in mentioning the following circumstance, although somewhat of a personal character. Berzelius, after being unable to prove by calculation the neutrality of salts

mutually decomposing each other, while basing his calculations upon the data of incorrect analysis, was often nearly abandoning the perplexing subject, but was induced by a paper of my father, upon the relation of the constituents of neutral muriates (published by him in 1806, a year before his death, in the 6th volume of "*Gehlen's neues Allg. Journal*," p. 22), to persevere. My father had, in the first place, by at least one example, practically demonstrated, that by the decomposition of two neutral salts, muriate of baryta and sulphate of soda, according to his own analysis of them, and of the two salts proceeding from the decomposition, and by calculation, results were obtained, which proved that the neutrality could not be disturbed.

Berzelius now considered it necessary, in order to attain to certain results, to investigate anew the composition of the most important compounds with extreme care, repeating the analyses several times before venturing to employ their results in the extension of his views. He remarked very justly, that, on account of the unchangeable neutrality of two salts decomposing each other, it was only necessary to analyze, with sufficient accuracy, all salts formed for example by sulphuric acid, and all those whose base is baryta, in order to be able, by a simple rule of three, to calculate the composition of all other salts, because these two series contain the three numbers which are necessary in order to find the fourth.

Berzelius now ventured upon an herculean task, which he prosecuted for many years with the most indefatigable industry, and for a long time without any help. He re-examined every important chemical compound with the most admirable care and exactness. In this work, especially, he displayed rare talent, selecting, with the most extraordinary acuteness, those bodies which were the best adapted for investigation. He published an account of his labors, or rather the commencement of them in the third part of the "*Afhandlingar i Fysik, Kemi och Mineralogi*" for 1810. They first appeared in German in 1811, in *Gilbert's Annalen*.

In these investigations, theory was constantly the touch-stone employed to test the accuracy of the results, to attain which he was frequently obliged to vary his experiments almost endlessly. He was, in the first instance, compelled to improve the analytical methods, and to abandon many of those in use at that time, and by this means he was gradually led to those views which are now received by all chemists.

The most distinguishing characteristic of Berzelius's mode of working was, that with the most insignificant means at his command, he still succeeded in obtaining the most brilliant results. When he entered upon his great investigation, he was in possession of very small pecuniary means, he was in a condition almost

of want, and without public support, which, considering the isolated situation of Sweden, must have been especially depressing and unfavorable. The difficulties against which he had then to contend were, in fact, enormous. At that time it was not possible to purchase in Stockholm pure reagents, as in Berlin; scarcely any chemical manufactories existed in the country, and to import reagents from abroad, for instance from Germany, was often scarcely possible, on account of the difficulty of communication, especially during the war, and at all times it was expensive and tedious. I have myself been a witness how Berzelius, even during the winter of 1820, while carrying out his important investigation of ferrocyanogen and ferrocyanid of potassium (which had long been procurable in Germany for a small sum per pound), was obliged to prepare this salt by the gramme. and indeed from a very bad material, the very impure Prussian blue of the shops. He was obliged to distil the spirit. the use of which in lamps he introduced, from ordinary brandy, and to prepare the most important acids himself, or to purify those which could be bought.

But it seems as if it was precisely those obstacles which would have discouraged and overcome any ordinary mind, that urged him on more perseveringly in his course. This is, moreover, a circumstance which has often occurred, and especially in Sweden: I need only call to mind Scheele, who almost made impossibilities possible.

Berzelius, in the first place, altered the methods of Klaproth, which at that time were the best, in so far especially that he employed considerably smaller quantities. The usual quantity operated upon by Klaproth and other chemists was rather more than five grammes; Berzelius never took more than two or three grammes, generally less, determining this quantity, of course, according to the nature of the constituents of the body to be examined. By employing more delicate balances, which Berzelius first introduced into use in chemistry, and by adequate care, results are obtained with a small quanity, which are at least quite as accurate, while they are obtained in much shorter time.

I had the good fortune during my youth to assist the meritorious Klaproth in his chemical investigations. though only during his later years, in the summer of 1816, when his labors were often interrupted by repeated attacks of illness. I was therefore enabled, while afterwards for several years in the laboratory of Berzelius. to compare the different manner in which Klaproth and Berzelius worked. Their methods had exactly the same relation to each other as the respective accuracy of their results.

The spirit-lamp, with double draught, was likewise introduced into use by Berzelius. Formerly the ignition even of the smallest quantities of a substance was effected over a charcoal fire. He was also the first to make use of the small platinum crucible,

in which, substances could be both ignited and weighed, and by the use of which considerably greater accuracy was insured, and the absorption of moisture as far as possible prevented. The filter containing the precipitate was always burnt when possible, and the ignited substance weighed together with the ash of the paper; a saving of time and trouble for which we are indebted to Mr. d'Ohsson, who worked in Berzelius's laboratory. It was on this account that a paper was employed which left after combustion but a very minute quantity of ash, and which was made of excellent quality in Sweden, because there are springs there rising through granite, the water of which is almost free from fixed substances. The general introduction of this Swedish paper, to the manufacture of which Berzelius paid great attention, is also owing to him.

The use of appropriate funnels, &c., as well as an immense number of other convenient applications originating with him, have contributed to render the results of analyses much more exact, and have much simplified the methods themselves.

Berzelius had moreover—and it is no slight merit—transferred chemical investigations in which charcoal fires were not necessary, from the damp kitchen, or cellar-like cold laboratory, into the comfortable dwelling-room. The present generation have scarcely an idea of the discomforts which were then connected with chemical researches. It certainly required no little scientific enthusiasm, during the severe winters of our northern climate, to remain in a place where there was the greatest absence of comfort, and which was even prejudicial to the health. But it was at that time thought that a laboratory with a stone floor was indispensably necessary even for trifling chemical operations.

The small caoutchouc tubes, by means of which experiments with gases may be so easily and safely conducted, and which, indeed, alone render many inquiries possible, were early employed by Berzelius in his investigations. Whoever has in former times attempted the collection of a gas will remember the unpleasantness of working with brittle glass tubes, and how easily an experiment failed from the slightest want of care. It was Berzelius who first rendered glass tubes, as it were, flexible, and they could then be employed in constructing the most complicated apparatus.

Possessing only the most scanty means, he was led to all these improvements by actual necessity. He took advantage of every opportunity to perfect himself in mechanical art. He was master of glass-blowing, which he learned from a travelling Italian; he was familiar with turning, glass-grinding, and other arts. He made the greater part of his own instruments; and notwithstanding the isolated position of his native country, was thus enabled to construct those ingenious forms of apparatus by means of which he so infinitely advanced the study of chemistry.

(*To be continued.*)

Art. II.—*Chemical Investigation of Remains of Fossil Mammalia;* by Francis V. Greene, M.D.

At the request of Dr. F. A. Genth, I have made in his laboratory a chemical investigation of several fossil remains, collected by D. D. Owen, M.D., in his late survey of Nebraska Territory; the specimens having been kindly furnished me by Dr. Jos. Leidy, from the collection of the Academy of Natural Sciences. The specimens consisted of a portion of bone from a Titanotherium, the enamel and dentine from a tooth of the same animal, and a portion of the tibia of the Archæotherium.

The general outline of the methods used is as follows:

The finely powdered substance, being always dried over sulphuric acid, was dissolved (according to H. Rose's method for the determination of phosphoric acid), in nitric acid, and after adding mercury in sufficient quantity to combine with the phosphoric acid, evaporated to dryness in a water-bath; afterwards it was moistened with water, and again evaporated to dryness; this operation being repeated until no odor of nitric acid could be observed at the temperature of the water-bath. To this dried mass water was now added. The insoluble portion consisted of nothing but phosphate and basic nitrate of mercury (except in one analysis, in which iron existed in a determinable quantity); the solution contained fluorid of calcium with the other constituents in the form of nitrates. The insoluble portion was separated by filtration, and, after being washed and thoroughly dried, was fused with carbonate of soda, with all the precautions mentioned by Rose. The fused mass consisting only of phosphate of soda and the excess of carbonate of soda, dissolved therefore completely in water, except in one instance. in which a portion of the iron remaining undissolved was filtered off, and determined in the usual manner. The watery solution was acidulated with hydrochloric acid and the phosphoric acid precipitated in the ordinary way by sulphate of magnesia and chlorid of ammonium.

From the solution containing the soluble nitrates and fluorid of mercury, the mercury was precipitated by chlorid of ammonium, and the filtrate from the calomel precipitated by carbonate of ammonia. As carbonate of lime and fluorid of calcium are not quite insoluble in ammoniacal salts, a small quantity of each was always deposited on evaporation of the filtrates from which they were separated by filtration and added to the other portions of carbonate of lime and fluorid of calcium. This precipitate was ignited, and an excess of acetic acid added, which dissolved the carbonate of lime, leaving the greater portion of the fluorid of calcium; but, as fluorid of calcium is soluble to a certain extent in acetic acid, the whole was evaporated to dryness to get rid of the free acetic acid, and the dry acetate of lime, dissolved

in boiling water, and filtered from the insoluble fluorid of calcium. Finding that it always contained a small quantity of silicic acid, the mixture, after being weighed, was treated with hydrochloric acid, which left undissolved the silicic acid, the quantity of which was determined and subtracted from the previous weight, thus leaving the exact quantity of fluorid of calcium.

The solution from the carbonate of lime containing only magnesia and the alkalies, was evaporated to dryness to drive off the ammoniacal salts, and the residue dissolved in sulphuric acid, the excess of which was also driven off by heat. The dry mass was dissolved in water, and acetate of baryta added to convert the sulphates into acetates. The filtrate from the insoluble sulphate of baryta, was now evaporated to dryness and heated in order to convert the acetates of baryta, magnesia, and the alkalies into carbonates, which were then treated with boiling water, and the soluble alkaline carbonates thus separated from the insoluble carbonates of magnesia and baryta. This latter mixture was then treated with dilute sulphuric acid, and from the filtrate, magnesia afterwards separated as phosphate of magnesia and ammonia. The carbonates of the alkalies were converted into and weighed as chlorids, and afterwards separated by bi-chlorid of platinum.

A new portion was taken for the remaining determinations.

This was dried at 220° until the weight became constant; the loss giving the quantity of water. The anhydrous substance was then heated in an open crucible until all the organic matter was burned off, and then moistened with carbonate of ammonia, as it was supposed that the high heat might have driven off a portion of the carbonic acid. The difference of weight gave the quantity of organic matter. Carbonic acid was determined in the usual manner from the loss of weight after treating with nitric acid. The nitric acid did not dissolve a small quantity of silicic acid, the weight of which was ascertained and added to that of the portion previously extracted. From the filtrate sulphuric acid was precipitated as sulphate of baryta.

The following are the data of the analyses:

1. *Bone of Titanotherium.*

I. 1·9136 grammes gave:

1·0200	grs.	of pyrophosphate of magnesia for determination of phosphoric acid.
0·0018	"	silicic acid.
0·0340	"	sesquioxyd of iron.
0·0137	"	fluorid of calcium.
0·0175	"	pyrophosphate of magnesia for determ. magnesia.
1·6995	"	carbonate of lime.
0·0504	"	mixed chlorids of potassium and sodium.
0·0127	"	platinum = 0·0096 chlorid of potassium.

II. 1·5776 grammes gave:

0·0090	grs.	of sulphate of baryta and silicic acid, which contained:
0·0086	"	sulphate of baryta, and
0·0004	"	silicic acid.
0·0404	"	sulphate of baryta for determination of sulphuric acid.
0·0645	"	carbonic acid.
0·0323	"	water.
0·0896	"	organic matter.

2. *Tooth of Titanotherium.*

a. Enamel.

I. 1·6226 grammes gave:

0·9966	grs.	of pyrophosphate of magnesia for determination of phosphoric acid.
0·0079	"	silicic acid.
0·0016	"	fluorid of calcium.
0·0099	"	pyrophosphate of magnesia for determination of magnesia.
1·4999	"	carbonate of lime.
0·0454	"	mixed chlorids of potassium and sodium.
0·0081	"	platinum = 0·0061 chlorid of potassium.

II. 1·8518 grammes gave:

0·0545	grs.	of sulphate of baryta for determination of sulphuric acid.
0·0023	"	silicic acid.
0·0586	"	carbonic acid.
0·0116	"	water.
0·0470	"	organic matter.

3. *Tooth of Titanotherium.*

b. Dentine.

I. 2·0083 grammes gave:

1·1318	grs.	of pyrophosphate of magnesia for determination of phosphoric acid.
0·0129	"	silicic acid.
0·0582	"	fluorid of calcium.
0·0297	"	pyrophosphate of magnesia for determination of phosphoric acid.
1·7829	"	carbonate of lime.
0·0356	"	mixed chlorids of potassium and sodium.
0·0095	"	platinum = 0·0072 chlorid of potassium.

II. 1·1643 grammes gave:

0·0509	grs.	of sulphate of baryta for determination of sulphuric acid.
0·0018	"	silicic acid.
0·0330	"	carbonic acid.
0·0245	"	water.
0·0310	"	organic matter.

4. *Tibia of Archæotherium.*

I. 2·1037 grammes gave:

1·0243*	grs.	of pyrophosphate of magnesia for determination of phosphoric acid.
0·1070	"	fluorid of calcium.
0·0668	"	pyrophosphate of magnesia for determination of magnesia.
1·7639	"	carbonate of lime.
0·0714	"	mixed chlorids of potassium and sodium.
0·0122	"	platinum = 0·0092 chlorid of potassium.

II. 1·7400 grammes gave:

0·0345	grs.	of sulphate of baryta and silicic acid, which contained:
0·0300	"	sulphate of baryta,
0·0045	"	silicic acid.
0·0814	"	sulphate of baryta for determination of sulphuric acid.
0·0395	"	carbonic acid.
0·0343	"	water.
0·0711	"	organic matter.

1. *Bone of Titanotherium.*

Compact, with subconchoidal fracture. Tough. Hardness 4·5. Sp. Gr. 2·810 (at 20° C.) Lustre resinous. Color brown. Opaque. On heating gives off ammoniacal water, together with the odor of burned horn. Contains:

* This quantity is rather too small, owing to a slight loss in the phosphoric acid; therefore in the analysis the loss was calculated as phosphoric acid.

F̈e	Ṁg	Ċa	CaFl	Ḃa	Ṅa	K̇	S̈i	S̈	P̈	C̈	Ḣ	Org. Mat.
1·777	0·348	49·837	0·716	0·359	1·134	0·317	0·135	1·067	34·148	4·088	2·048	5·682=101·656

with a trace of manganese and chlorine: which may be considered as

$2Fe_2O_3, PO_5$	2·821	$3CaO, SiO_3$	0·382
$3MgO, PO_5$	0·770	CaO, CO_2	9·315
$3CaO, PO_5$	69·685	CaO	6·605
$2NaO, PO_5$	1·415	CaFl	0·716
BaO, SO_3	0·547	HO	2·048
NaO, SO_3	1·083	Org. Mat.	5·682
KO, SO_3	0·587		101·656

2. *Tooth of Titanotherium.*

a. Enamel.

Fibrous, with uneven fracture. Very tough. Hardness 4·7. Sp. Gr. 4·7 (at 20° C.) Color bluish gray. Opaque. Lustre—surface subvitreous, fibres pearly. Contains:

Ṁg	Ċa	CaFl	Ṅa	K̇	S̈i	S̈	P̈	C̈	Ḣ	Org. Mat.
0·219	51·872	0·099	1·288	0·239	0611	1·011	39·348	3·165	0·626	2·538=101·016

with traces of oxyds of manganese and iron: which may be considered as

$3MgO, PO_5$	0·403	$3CaO, SiO_3$	1·727
$3CaO, PO_5$	83·835	CaFl	0.099
$2NaO, PO_5$	1·413	CaO	1·284
NaO, SO_3	1·437	HO	0·626
KO, SO_3	0·442	Org. Mat.	2·538
CaO, CO_2	7·212		101·016

3. *Tooth of Titanotherium.*

b. Dentine.

Compact. Fracture uneven, somewhat subconchoidal. Hardness 2·5. Sp. Gr. 2·935 (at 20° C.) Lustre dull. Color white, with gray spots and black streaks. Assumes a greenish tint when heated in presence of air, from the formation of manganic acid. Contains:

Ṁn	F̈e	Ṁg	Ċa	CaFl	Ṅa	K̇	S̈i	S̈	P̈	C̈	Cl	Ḣ	Org. Mat.
traces	0·53	49·82	2·90	0·75	0·23	0·79	1·51	36·10	2·83	*trace*	2·10	2·66=100·22	

with traces of oxyds of manganese and iron: which may be considered as

$3MgO, PO_5$	0·98	CaO, CO_2	6·45
$3CaO, PO_5$	77·81	CaFl	2·90
CaO, SO_3	0·60	CaO	2·35
NaO, SO_3	1·71	HO	2·10
KO, SO_3	0·43	Org. Mat.	2·66
$3CaO, SiO_3$	2·23		100·22

4. *Tibia of Archæotherium.*

Compact; fracture uneven, somewhat splintery. Hardness 4. Sp. Gr. 2·826 (at 20° C.) Lustre pearly. Opaque. Color pink-

ish white. Assumes a greenish tint when heated in presence of air. Contains:

$\dot{M}g$	$\dot{C}a$	CaFl	$\dot{B}a$	$\dot{N}a$	$\dot{K}$	$\ddot{S}i$	$\ddot{S}$	$\dot{\ddot{P}}$	$\ddot{C}$	$\dot{H}$	Org. Mat.
1·140	47·052	5·086	1·131	1·572	0·276	0·259	2·200	32·957	2·270	1·971	4·086=100·000

with traces of chlorine, and oxyds of manganese and iron; which may be considered as

$3MgO, PO_5$	. .	2·099	CaFl	. . . 5·086
$3CaO, PO_5$	. .	68·582	CaO	. . . 6·517
$2NaO, PO_5$	. .	1·079	$3CaO, SiO_3$	. . 0·732
BaO, SO_3	. .	1·723	HO	. . . 1·971
NaO, SO_3	. .	2·443	Org. Mat.	. . 4·086
KO, SO_3	. .	0·510		100·000
CaO, CO_2	. .	5·172		

With very few exceptions the analyses which have heretofore been made, show in the inorganic part but a slight difference between recent and fossil bones, which fact is sustained by the results of the present analyses. In the above investigations, a comparison with the analysis of a recent bone, shows that most of the organic matter has been destroyed, while the inorganic has undergone only slight changes. The difference in composition between these specimens and recent bones, can be satisfactorily accounted for by the effects of infiltration, by which new substances have been introduced, whilst a portion of the original constituents, being converted into soluble compounds, was washed out.

All the analyses present an excess of lime, which very probably exists in the form of a basic lime salt, as occurs in compounds well known in mineralogy.

The fluorid of calcium was determined as carefully as possible, to test the correctness of the opinion of some writers, who consider that fossil bones contain fluorid of calcium in a larger proportion than recent ones; but in no instance was so large a quantity found as in the analysis of fossil reptiles by Baumert,* where the fluorid of calcium in the Zeuglodon macrospondylus amounts to 9·54 per cent., and in the Hydrarchos to 16·67 per cent. By direct determination, Heintz† found the fluorid of calcium in two human bones to be 2·97 and 2·05 per cent.; the first of which corresponds exactly with the quantity found in the dentine of the Titanotherium. In the tibia of the Archæotherium a portion of the fluorid of calcium may have been introduced in a manner similar to that of the quartz and sulphate of baryta.

* Liebig und Kopp, Jahresbericht für 1851, p. 594.
† Pogg. Ann., vol. lxxvii, p. 267.

Art. III.—*A Consideration of some of the Phenomena and Laws of Sound, and their application in the Construction of Buildings designed especially for Musical Effect;* by J. B. Upham, M.D., Boston.

(Concluded from p. 363.)

We have already pointed out how the resonance of a room, and the quality of the transmitted tone, are affected by the conformation and structure of its walls. Were these the only modifications of the original sound produced by the materials which circumscribe the limits of any apartment, the indications were plain; for, as we have seen, the same conditions that are necessary for a proper amount of resonance are those, also, required to maintain the strictest purity of intonation, so far as relates to the passage of sound from a denser to a rarer medium, and *vice versâ*.

But every sound shut in by the walls of a building, is subjected to the disturbing influences of reflection and reverberation. These are consequences which it is of the utmost importance to control or subdue, and, these also, are materially modified by the nature and conformation of the circumscribing limits. Unfortunately, the conditions of structure that would favorably affect the first mentioned desirable results, might unfavorably modify the latter. To explain:—so far as resonance and the perfection of the transmitted tone are concerned, the unity of structure required in the main body of the wall should not be disturbed at its surface; in other words, the internal face of such wall should be the solid surface of the substance used in its construction.* Now a wall of masonry, presenting a smooth and solid surface to the sound, will occasion an excess of the residuary portions which constitute direct reflection and reverberation; so that, however satisfactory be the effect of an isolated musical tone, the distinct utterance of a succession of sounds in moderate rapidity is rendered impossible. This is abundantly confirmed by observation and experiment. In a metallic chamber at Montrose, which had been constructed for the preparation of sulphuric acid, Dr. Reid observed that any sound produced in it continued in general for seven or eight seconds after the impulse which had given rise to it had ceased. In the interior of one of Barclay and Perkins' boilers,

* In illustration of this principle, witness the injurious effects of combining a variety of materials in the construction of musical instruments upon their free vibration, and the purity of tone imparted. Thus a flute, of which a part is ivory and a part wood, or a portion of which, as in the modern instruments is mostly the case, is sheathed with a lining of metal, loses in great degree its pure and mellow tone, though it acquires thereby, in its upper register, a certain piercing quality (brilliancy perhaps,) which gives it a greater prominence in the orchestra, and compensates, in the ears of many, for its losses in other respects.

sound produced in the same way, he states, continued for eight seconds. To these we may add our own observations in the obnoxious rooms at Girard College (before mentioned) which present an even and solid surface of stone internally. So also, in the case of the Musical Fund Hall in Philadelphia. This room is one hundred and twenty-one feet long, sixty broad and twenty-five and a half high to the centre of the arched ceiling, the depth of the arch, four feet four inches, included. Instead of being plastered upon a lathing, battened in the ordinary way, it has a smooth, solid finish upon the face of the wall. By experiments made in this apartment, when empty, we found a reverberation of peculiar intensity, which lasted four to four and a half seconds: on striking the wall, at various points, a sharp, clearly-defined echo was returned. Experiments in other rooms similarly situated, led to a like result.

How to provide fully in one and the same structure for results thus seemingly incompatible is a problem not easy to be solved. It seems to us, however, that walls of solid wood (fir or pine being preferred,) are fittest for the purpose, as containing, in the largest measure, the conditions required. Here alone, perhaps, can be found united the requisites for a free admission and conduction of the sonorous pulses with the conditions favoring also the suppression of excessive echo and reverberation. But, as we have before remarked, the expense of such a mode of building, together with its greater attendant risk in a large city, may prove an insurmountable objection to its use.

With a structure of masonry, means should be adopted to overcome, in some measure, the evils just mentioned (excessive reverberation, &c.); and we know of no way by which this can be better accomplished, with the least detriment in other respects, than by the plan of battening and wainscoting the walls, or of lathing and plastering upon them, after the ordinary methods employed in carpentry.* Thus we gain a *sound-surface* less impenetrable and unresisting than that of the solid walls, while the sonorous waves in their passage to the masonry beyond, find conditions as favorable to the free vibration of the whole structure as the nature of the case will admit. In this mode of finish, a space is left between the surfaces, which greatly assists absorption of the injurious excess of sound. A lining or sheathing merely, whether of wood or any other substance in *immediate contact with the wall*, not only excludes this provision but is objectionable, also, on the ground that it thus becomes more an integral part of the solid structure, destroying in greater degree that homo-

* We would be understood here to use the expressions *wainscoting* and *lathing and plastering*, in contra-distinction to a mere lining of wood or a layer of plaster upon the solid walls direct: (the profession will pardon us if we misuse their technicalities.)

geneity which it is our aim to preserve. It is analogous in its effects to the sheathing of a musical instrument.

One other question of practical utility comes up in this connection, viz.: as to the comparative superiority of thus battening and wainscoting such solid wall with wood, or of lathing and plastering it in the usual manner. Our preferences are in favor of the employment of wood for this purpose, substantially for reasons above stated.

As regards the subjects of VENTILATING, WARMING and LIGHTING, they have a broad range, and demand alike the attention of the architect, the philosopher and the philanthropist. Hitherto their importance, even in a sanatory point of view, has been too often overlooked or neglected. But aside from a due consideration for the health and comfort of a crowded audience, they are points which affect materially the acoustic properties of a room.

The conditions of the external atmosphere required for the greatest intensity, clearness and purity of tone, have been fully stated in a previous number. The effect of the different gases, and of a mixture of gases, vapors, or liquids of different chemical and mechanical natures, upon the communication of sound, has likewise been shown. From such facts and illustrations it is plain that whatever conduces to the purity of the contained air of a room, to its quiescent and equable state, uniformity of temperature and freedom from draughts and partial currents, adds to the truthful interpretation of sound therein. We are convinced the matter has not yet been sufficiently considered in this light, although the attention of the public has at various times been directed this way*. Dr. Bell, in his instructive address delivered before the Massachusetts Medical Society, in May, 1848, on the Practical Methods of Ventilating Buildings, thus recognizes the claims of his subject in this particular.

"Under the recent advances in this science, a true ventilation is designed, also, to comprehend the acoustic relations of the air, as well as its more palpable and material admixtures. At first thought, it may appear somewhat fastidious, and even unphilosophical, to regard merely unwelcome sounds, recognized by the ear alone, in the light of offensive impurities, or rather as disagreeable additions to the medium in which we live and intercommunicate, yet no explanation will be needed by a body of medical practitioners, residing, in part, in large towns and cities, for considering the means of obviating, or alleviating, the annoyances and injurious irritations of painful sounds, in the same category with the disagreeably offensive or actually malarious contaminations.

* * * * * * * *

"It is a gratifying coincidence, which will most fully develop itself, as the various modifications of the ventilating system are brought for-

* Vide Reports of the Parliamentary Committee in 1833 and 1835; and the able treatises on ventilation and warming by Tredgold, Reid and Wyman.

ward, that the improvements which have so fully satisfied the requirements of health and comfort, as respects respiration and purity to the senses, also meet the necessities of the ear. We shall see that under the complete arrangement for atmospheric supplies, secured in modern provisions, this rather more remote requirement is completely fulfilled, a necessity of the highest moment, as regards that somewhat extensive class of edifices, assembly rooms and halls, in which distinct and easy elocution, or the completest delivery and reception af musical sounds and literary compositions, are the principal desiderata.

"Under the aids of forced ventilation, or that on which an independent motive power is relied upon, all varieties of system require, as a condition of their full effect, the avoidance of any direct communication with the outside air, by the closure of all windows or openings which might admit foreign, or confuse designed vibrations. Hence, the purest effort of speech and music are transmitted to the audience, unmutilated and unmixed, and with the least labor and pain on the part of the vocal performer. The most refined enjoyments of the musical art, the most persuasive and overpowering effects of eloquence, and the full weight of instructive attempts, thus mingle their claims for consideration in this useful science, as well as the more immediate and pressing demands of body and mind, for exemption from disease, prolongation of days, and the highest intellectual and moral exercises."

It is much to be regretted that the orator did not, in this connection, suggest the details of a plan that would satisfy, in his own view, the merits of the cause he so eloquently pleads. We have not, however, space in the compass of this essay to discuss the science of ventilation, as at present understood, and its application to buildings of various kinds, but can only refer to such of its principles as we conceive are best adapted to our present purpose, leaving the details mostly for the imagination to supply.

Regarding the main object of a true ventilation to be the constant removal of the vitiated air and its immediate substitution by fresh supplies, the proposition now before us, is how most effectually to accomplish this end, with a just regard to the acoustic requirements which the uses of the structure demand. It is true we cannot, by any plan of artificial ventilation, fulfill all the conditions that would be desirable, for, as appears by the very nature of the case, there is required, in the room to be ventilated, a constant motion of the contaminated mass of air that its place may be filled with purer supplies from without, thus manifestly interfering with that state of absolute stillness and rest, which we have seen is essential to the perfect appreciation of sounds in the external world. But although such perfect excellence may not be obtained, we believe a nearer approximation to it can be made than exists in any hall for music of which we have knowledge.

It is a beautiful provision in nature, whereby the noxious products of respiration and combustion are carried upward by the

mass of heated air with which they are mingled. Hence is derived an important indication for an effectual system of artificial ventilation. And it seems to us especially necessary in the present case, that, whatever modification circumstances may require in other respects, the plan of introducing the pure air *from below* and providing for its discharge *above*, when vitiated, should be rigidly adhered to. Thus shall we most readily and quietly ensure the removal of all existing elements of acoustic disturbance, with the least danger of admitting new causes of a like tendency.

In a room, containing a crowded auditory, artificially lighted and warmed in the usual manner, the air becomes rapidly loaded with the products of respiration and combustion, and, too often, by the addition of coal gas from the furnace flues. The changes induced by these processes, in the surrounding medium, are abstraction of oxygen and the addition of carbonic acid gas and moisture, with inequality of temperature and the creation of noxious draughts at various points, all which tend to destroy that homogeneous and equable state of the air which we have found so desirable in its acoustic relations.* With a given audience the result of these changes upon sound is appreciable in a degree usually inversely proportioned to the cubic capacity of the room.† In its general provisions, the plan adopted by Dr. Reid for ventilating the temporary House of Commons seems admirably fitted to meet the exigencies of the case. His system was devised expressly to satisfy both the sanatory and acoustic requirements of that room. We take the following condensed account of it from the published address of Dr. Bell before quoted from.

"A series of openings through the wall into a court-yard, admits the fresh external air to the basement of the building. A suspended fibrous veil, 42 feet by 18, hangs before the external openings, the object of which is to separate the mechanical impurities, especially the flakes of soot, of which the London atmosphere is full, 200,000 visible portions having been arrested in a single evening.

"The air thus screened, is next passed into a *receiving chamber*, constituting about one-third of the basement. A partition divides this its whole length. At the middle of this wall, an opening permits the air to pass through an apparatus in which, by a thousand jets of water crossing each other in every direction, it is washed and moistened. It then

* It has been determined from experiments on animals and from its observed effects on men, that an atmosphere containing one per cent. of carbonic acid gas must be considered injurious to health, and as requiring immediate ventilation —*Dr. Wyman's Treatise*, p. 78.

W. T. Brande, Esq., states that he once examined the air in the upper part of Covent Garden Theatre, and found in it *three per cent.* of carbonic acid gas, produced by vitiation and imperfect ventilation. The same gentleman also declares that coal gas destroys (for breathing) thrice its bulk of oxygen and fifteen times that of air. —Vide *Report of the Committee on House of Commons Buildings appointed in* 1835.

† For the striking effects of mixed media in obscuring and stifling sound, the reader is referred to the illustrations given in the first part of this essay.

passes amongst iron tubes filled with hot water, by which its temperature is raised to any required degree. It now reaches a long chamber, parallel to the receiving chamber, from various parts of which apertures are left which allow the air to pass up into an *equalizing chamber* above, which extends under the whole Hall of Assembly. As the current passes up, it impinges against a flat board at each aperture, raised a short distance above, called a *disperser*, which throws the air somewhat horizontally, breaking the upward current.

"No less than 300,000 gimlet holes of a conical shape, with the smaller orifice upward, to prevent clogging by dirt, allow the air to escape into every part of the room above; and to make its diffusion more perfect, a hair cloth carpet, woven porously for the purpose, gives it an extreme and universal separation.

"The escape of vitiated air is provided for at the top of the room, where holes are left from one end to the other into a horizontal channel above, which is received into a descending flue passing to the ground and communicating with the lower extremity of a brick chimney, 110 feet in height. A fire grate, with a door of supply for fuel, is placed in the centre of this shaft, a portion of the air passing under it to supply the combustion, and the larger remainder at its sides. A valve or register, suspended in the main foul-air channel at the point above the ceiling where it turns to descend, regulates the rapidity of movement, and consequently, the quantity of air which is drawn through the house. It may be well to mention that the size of the room is 80 feet by 40, and 30 feet in height."*

Mr. John Sylvester, engineer, presented to the Parliamentary Committee a plan very similar in its provisions to that just described. He also proposed to admit fresh air to the House, first passing it above a cast iron apparatus heated by steam or hot water, through small inlets over the whole area of the floor, and provided for its exit by apertures in the ceiling. The combined area of the apertures he estimated at about 665 feet, through which he supposed the air of the house would be changed six times per hour. He estimated the entire capacity of the house at 200,000 cubic feet.†

In both these plans some important points are recognized, to which we would here direct attention as especially applicable to our present subject;—and, first, the *extreme diffusion* to which the air is subjected as it enters. In the ventilating and warming arrangements of our large halls for music and other public purposes, this most important principle is almost invariably transgressed. The hot air is admitted at two or three points, in large

* For a full description of these arrangements with diagrams, vide Reid's Illustrations of Ventilation, page 270 et seq.

An evidence of the remarkable uniformity of temperature maintained in the House of Commons, under this system, will be found in the tabular records in Dr. Wyman's Treatise, page 226.

† Report from the select Committee of the House of Commons, on ventilation, warming and transmission of sound, with the Minutes of evidence, 1835.

masses, through registers, not unfrequently placed along the central aisle of the room, and, not readily mixing with the surrounding atmosphere, rises in unbroken columns to the ceiling, whence it is at length diffused. By these shafts of heated air the sonorous vibrations are refracted, confused and obscured, the philosophical explanation of which we have already shown in the analogous effect upon light passing through strata of different densities and natures. The testimony of Dr. Reid in this particular is important. In his evidence before the Parliamentary Committee, he says:

"Another interruption to sound is the great body of air rising from the middle of the House, when the heating apparatus is in action; from this cause members cannot hear on the opposite sides, or the speaker persons at the bar."

One of the Committee also, when Reid mentioned this circumstance, stated that he had often noticed he could not hear a member opposite him distinctly, at particular times, unless he shifted his seat along the bench; and on examining the place referred to, it was found that he had moved to a position where the hot current no longer passed between him and the member speaking.* If not found practicable to give the air on its admittance the universal diffusion suggested in the plans just quoted, it can be made to enter after being previously tempered, beneath the benches all over the house, or through a continuous succession of apertures pierced in the floor, along the borders of the room, where an aisle might be left for that purpose. Better still, perhaps, a channel might be left in the walls close to the floor, and extending completely around the room, masked by perforated panel work, through which the attempered air would gradually flow into the apartment. It would be easy, in this way, to obtain an aggregate area of inlet apertures equal to that proposed in Mr. Sylvester's plan.

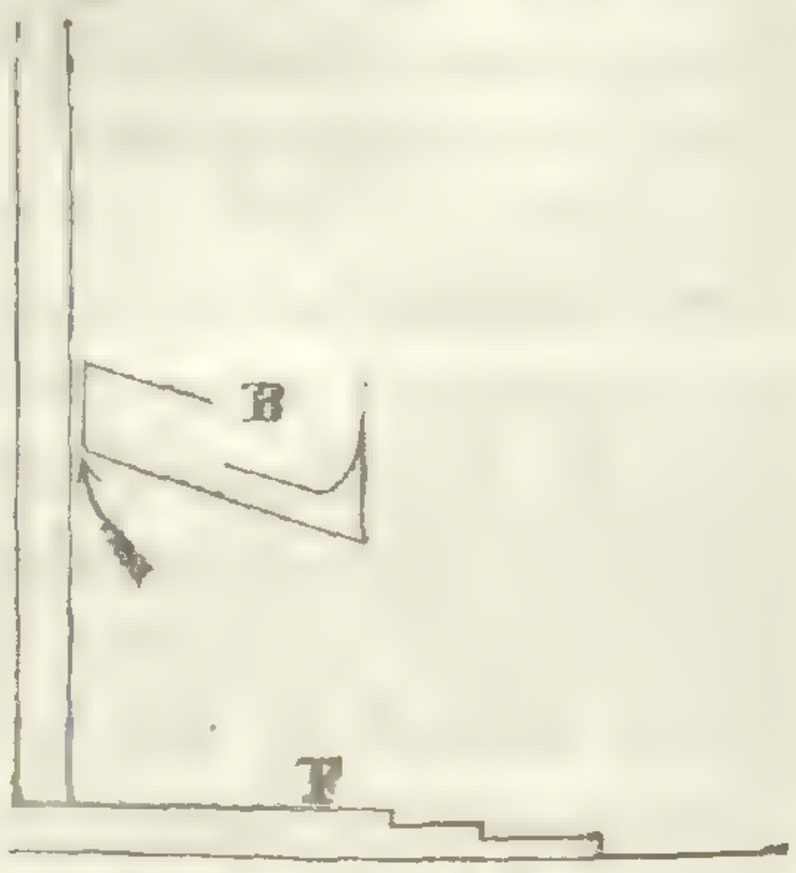
Not less important is it, also, to secure a *gentle and equable movement* of the entire mass of air through the apartment. With properly graduated inlets and outlets, arranged in the manner just described, together with the provision of a constant, controllable motive power (which is all important,) this result would naturally follow, were it not for other and foreign elements of disturbance.† Among the most serious of these is a predominance of

* In the old Tremont Temple at Boston, the air was introduced in this way, as is still the case at the Melodeon in that city and at the Musical Fund Hall in Philadelphia. At the Metropolitan (formerly Tripler) Hall in New York, the heated air is admitted through a series of registers placed along the sides of the room and escapes through a masked aperture in the centre of the ceiling: this, *so far as it goes*, is an improvement on the methods commonly employed amongst us, but the mode of lighting and the construction of the hall generally are faulty.

† Mr. Sylvester estimated that in his arrangements, the rate of the air's motion into the house would be half a foot per second, or about one-third of a mile per hour. At this rate, he says, a volume of air scarcely moves the most sensitive flame.

windows in the walls, inducing cold counter currents, which, in descending, bring down with them also the noxious vapors from above to mingle with the air of the room again.* This is an additional reason why windows in this situation should be as infrequent as possible; (we have before hinted at their injurious acoustic influence in other respects).

Again the various accessories and appendages to the main apartment are often a source of offence. Corridors, lobbies and entries, imperfectly warmed and ventilated, will give rise to sudden gusts and eddies of cold air, alike uncomfortable to the audience and injurious, in their general effect on sound. Much can be done here, as suggested by Dr. Bell, by duplicating the doors at the extremities of every passage or entry, so that the one in front is not opened till that in the rear has thrown itself to.† Underneath deep galleries the atmosphere is in a different state from that in the body of the room, and hence the difficulty often experienced in hearing distinctly in such situations. Moreover the heated air which there collects, is all the while pouring out in front, whence it rises in a tenuous wavy sheet to the roof, to the manifest discomfort of the occupants of the gallery itself. In such cases a narrow aperture left at intervals at the back of the projecting gallery, between it and the wall, as in the annexed figure, would obviate these evils and aid in preserving the unity and homogeneity of the air in the main body of the house.



B, Balcony.—F, Floor.

Care also should be taken in the arrangement of the ventilators in the ceiling, that too much sound do not escape with the vitiated air.

Dr. Wyman instances the case of a chapel, in which an opening for ventilation was made in the ceiling of an organ loft, directly over the organ. He states that when the chapel was crowded, and the current through the opening considerable, the organ became nearly inaudible to those upon the floor; the difficulty ceased immediately on closing the opening. Sound, we have seen, does not easily turn at right-angles; taking advantage of this fact, these outlets, as we have elsewhere explained, can be

* In confirmation of this effect of a surface of cold glass in disturbing the quiescent state of the air of a room, vide Wyman's Treatise, page 125.

† In fact, the cross draughts, supplies from sources and emissions of air at points not determined by the motive power, would be utterly inconsistent with any uniformly arranged plan. As Dr. Reid well remarks, the apartment to be ventilated on a scientific plan, is to be deemed and treated as a piece of philosophical apparatus, the results of the operation of which are to be interfered with by no fortuitous influences.—*Dr. Bell's Address*, p. 71.

contrived so that the vitiated air may readily enough escape, without a corresponding loss of sound.*

So intimately joined are the departments of ventilation and warming in their practical operation, that in treating of the former subject we have necessarily included, to some extent, the latter.

Connected with the warming of a building, such as we are now considering, there are two points of practical importance that are mainly to be considered, viz: First the propriety of uniting the mechanical appliances for heating and ventilation in one and the same plan; secondly, the nature of the apparatus to be employed, whether steam or hot water pipes, or the common furnace.

As regards the first of these questions, it appears to us preferable, considering all the objects to be accomplished, that the fresh air should be so attempered on its admission as to serve also to warm the apartment. In this way, while we gain an equally efficient ventilation, we can better secure a uniform temperature and avoid the existence of injurious currents, than if the warm and cold air were allowed to enter at different points. It would be well if the room were always warmed, previous to its use, to within a few degrees of the point required when the audience are present, inasmuch as the entering current will not immediately mix with air of a different temperature. To serve the purposes of a summer ventilation, or to allow the admission of cold air, if required, without its passing across the heating apparatus, a very simple arrangement only is necessary.

Concerning the second point, our preferences are decidedly in favor of the use of steam or the mild hot water apparatus, over every other system of which we have any knowledge. The question of its greater expense, we conceive, should not be placed beside its manifold advantages. As we have not room now for the discussion of these points, we refer the reader to the able treatises of Tredgold and Arnott for a full exposition of the superior virtues of the plan we would adopt; suffice it for us to say here, that in this way, only, do we believe an agreeable, salubrious and equable atmosphere in a large room, can be made certain.

But the methods to be employed in ventilating and warming a building intended for sound, are not alone in deserving a careful consideration; the manner of *lighting* the apartment also is not unimportant. Here the same principles are to be kept in view that have been previously stated. In the ordinary methods of artificial lighting, whether from gas, oil, wax or tallow, the air of a room is rapidly contaminated and admixed with the va-

* Saunders, in his treatise on theatres, recommends that these ventilators be closed during the performance of the piece and opened only between the acts. This however, is going to the opposite extreme.

rious products of combustion before enumerated. Moreover, by their injudicious position and arrangement, these lights have often a powerfully disturbing effect upon that state of quiescence in the air of an apartment which we have found so essential for the exact appreciation of sound. From this cause the foot-lights in front of the stage are inconvenient and objectionable, as the waving stream of hot air above them induces an amount of rarefaction, which impairs alike the sound and the distinctness of vision. A similar influence, as respects those seated behind them, has the row of gas burners so commonly affixed to gallery fronts and balconies. Chandeliers, pendent from the roof, however beautiful to the eye, are also offenses to the ear, which a rigid regard for acoustic excellence in a room would prohibit. Perhaps the extreme of consideration, in this respect, amounting almost to fastidiousness, is to be found in Dr. Reid's *exclusive system*, as he calls it, which he proposed for lighting the new Houses of Parliament. Here the illuminating source was entirely outside the space to be lighted, the light being diffused from pendants in the ceiling, or passing down through a cornice of glass which extended all round the room. Commenting on this plan, in the volume before alluded to, he remarks:

> "It will be obvious, that in some buildings, few lights would be more practically useful and agreeable than a series of gothic pendants with illuminated drops, appearing like stars diffused over the ceiling."

The system of lighting adopted in the Boston Music Hall is such as to avoid entirely the acoustic disturbances above mentioned, while, at the same time, it acts as the effectual motive power to the ventilating arrangements of the Hall. Here, as in the celebrated Philharmonic Hall at Liverpool, the gas jets are placed on the top of the cornice, at a height of fifty feet above the floor, and all the products of combustion escape immediately through the ventilating apertures above.

Having thus alluded, in a general way, to the main objects of ventilation, warming, and lighting, as applied to halls designed for acoustic effect, we leave the subject, for our space will not allow us to enter minutely into the description of a plan, that might comprehend all the virtues and avoid the evils we have named. We are sincere in the belief, however, that the condition of the common medium "in which we live and intercommunicate," and through which all sounds are conveyed to the ear, is a subject demanding the attention of the architect, who aims to construct a fitting abode for his kindred art, no less than the material shapes with which he would form and limit its bounds.

At this stage of our subject, there still remain a few points for consideration, which have a bearing upon the complete result.

It has been a mooted question among many, whether the surface of the walls and ceiling, in a room intended for sound, should be plain or broken at intervals by pilasters, panels, and ornaments of various kinds. The opinions of the architects before the Parliamentary Committee were divided in this particular; but the bulk of general evidence is decidedly in favor of the latter plan. Mr. J. Scott Russell advocates the use of pilasters against the walls of a room, to interrupt the oblique waves which fall along the surface, and constitute reverberation, on his theory.* Although our own views, as previously explained, differ, in some essential points from those adopted by Mr. Russell as to the nature of reverberation, they would seem even more strongly to require the provisions he has laid down for the amelioration of it; and, as we hinted when treating of the subject of harmonic relations in musical rooms, we would also argue the propriety of placing such pilasters, or other projections, at points corresponding with the nodal divisions of the wall. For analogous reasons we believe that coffers, cross-beams and deep mouldings in the ceiling are beneficial to sound. Practically, there is certainly much to favor these views. The best music halls in England have their walls treated in this manner. Says Robert Dale Owen on this point;

"It may be remarked that the ribs with deep mouldings intersecting each other on the Norman or Gothic vault, and thus paneling its surface, are not to be taken as mere ornamental features. In churches or halls designed for public speaking, as also in spacious school-rooms or the like, if the ceiling, whether flat or arched, be deeply panelled, the reverberation of the voice is checked, so as greatly to aid the speaker. Had the caissons in the dome over the Representatives' Hall in the Capitol at Washington been *actually sunk*, as in that over the Senate Chamber, instead of being merely *painted* on a smooth surface, it would undoubtedly have rendered that Chamber somewhat more suitable for public speaking."†

It was made an important feature in Dr. Reid's plan for a House of Commons, that the porous floor, while it allowed the diffusion to the attempered air, admitted for the purposes of ventilation, provided also a ready means of escape for the excess of

* It is a mistake to suppose that Mr. Russell has the merit of having first suggested the use of pilasters in this connection. They were recommended by Dr. Reid many years before, and on much the same grounds as those subsequently adopted by Mr. Russell.—*Vide Report on House of Commons Building*, 1835.

† At the National School the plaster of the ceiling was removed but the ceiling joists left, by which the excessive noise that formerly prevailed was greatly reduced. —*Reid's Illustrations.*

The ceiling of the chemical lecture room in the East wing of the Smithsonian Institution is a Norman groined vault, intersected by ribs with deep mouldings. This room is found to be perfectly adapted for public speaking, and free from any unpleasant reverberation.—*Owen's Hints on Public Architecture.*

Vide also Inman and others in confirmation.

sound reflected from the ceiling. But it would seem that under ordinary circumstances, in a room constructed in accordance with the views above given, the clothing of the audience and the cushioned seats on the floor of the hall afforded sufficient material for the absorption of sound. And it is an easy matter to increase this effect to any required extent, by the judicious employment of upholstery and carpeting.

GALLERIES are generally regarded as prejudicial to sound. But they are almost necessary evils, when it is required to accomodate with comfort an auditory of three or four thousand persons, without extending unduly the area of the floor. What adds much to their injurious effect is the unreasonable depth with which they are ordinarily constructed, thus necessitating for their support the use of pillars, by which the pulses of sound are interrupted and broken: and when, as is mostly the case, these galleries have floors shelving back to the wall, with no provision for ventilation at that point, they become (as we have before suggested) vast receptacles for the impure air beneath. It seems to us, moreover, that a gallery, although it be so fashioned as to escape the evils just mentioned, is injurious in other respects, to the musical qualities of a room, when placed in immediate contact with its walls; for by impeding the free vibration of the latter, it must tend to destroy their resonance, acting, in this case, much in the same way as a damper placed upon a vibrating string, or a mute on the bridge of a violin.

The position of the ORCHESTRAL STAGE has become fixed by custom. There are those, however, who would have it removed to a point nearer the centre of the room, and for good philosophical reasons. Chladni and Herschell are among the advocates of this change, on the ground that the original impulse, being then more equally distant from all the walls, the hearer would suffer less from the effect of secondary or reflected sounds. On the same principle it might be urged also that the platform should be raised much higher from the floor than is usual, in order to lessen the appreciable amount of reflection from the roof. Considered wholly in reference to the truthful interpretation of the sound by the room itself, such is no doubt the correct doctrine. But in the first instance, we should lose the benefit of a solid reflecting surface behind, which serves to reinforce the original sound by a reflection so nearly synchronous with it as not to be appreciable by the ear; and in both, a considerable portion of the assembly must be deprived of a favorable view of the occupants of the stage. It is better, perhaps, to adopt a middle course between the two in this respect, aiming to satisfy, as nearly as may be, the acoustic requirements of the room with a just regard to the comfort and convenience of the audience.

A word here as to the disposition of the singers and instrumental performers themselves; and this is not a matter of indifference as regards musical effect. So far as position *can* do it, the various voices and instruments should be so grouped and arranged as to be recognized by the hearer, duly as parts of one integral whole; and for this most complete fusion and blending of all in one, there is required in every plan, some common point towards which the sounds may be delivered. The extremes should be within a moderate neighborhood of each other, and those in rear but little raised above the performers in front; in order thus to induce a greater sympathy of feeling and consequent co-operation of action, than when separated and individualized as they otherwise are.

Parabolic reflectors and recesses of other forms in rear of the orchestra can be productive only of injury to the general effect, for inasmuch as all upon the stage cannot be in the focus, the greater indistinctness and confusion only will follow from their use.

Again, *newness of structure* has its influence in the sounding qualities or intonation of a room. Here, as in many musical instruments, age seems in some measure to mellow down the asperities at first noticed. How this results it is perhaps not easy to explain. Can it be that from the constant vibration imparted by the sonorous impulses to the solid materials some change is gradually induced in the arrangement of their integral molecules, after the manner in which agitation sometimes affects the intimate structure of crystallizable bodies? But doubtless much is to be attributed to the natural effect of time in drying and consolidating and thoroughly assimilating the structure in all its various parts.

We here conclude our imperfect essay, ending as we began, with the regret that architects and scientific men have not honored with a more careful attention a subject so full of interest and so intimately connected with the welfare of an Art, now almost universally known and appreciated.

ART. IV.—*On the discovery of some Fossil Reptilian Remains, and a Land-shell in the interior of an erect fossil-tree in the Coal measures of Nova Scotia, with remarks on the Origin of Coal-fields, and the time required for their formation;* by Sir C. LYELL, F.R.S., V.P.G.S., &c.*

THE entire thickness of the carboniferous strata, exhibited in one uninterrupted section on the shores of the Bay of Fundy, in Nova Scotia, at a place called the South Joggins and its neighborhood, was ascertained by Mr. Logan, to be 14,570 feet. The

* From Proc. Royal Soc. of Great Britain, March 18, 1853.

middle part of this vast series of strata having a thickness of 1400 feet abounds in fossil forests of erect trees together with root-beds, and thin seams of coal. These coal-bearing strata were examined in detail by Mr. J. W. Dawson of Pictou, and Sir C. Lyell in September last (1852), and besides other results of their investigations they obtained satisfactory proof that several Sigillariæ standing in an upright position, or at right angles to the planes of stratification, were provided with Stigmariæ as roots. Such a relation between Sigillaria and Stigmaria had, it is true, been already established by Mr. Binney of Manchester, and had been suspected some years before on botanical grounds by M. Adolphe Brongniart; but as the fact was still doubted by some geologists both in Europe and America, it was thought desirable to dig out of the cliffs, and expose to view, several large trunks with their roots attached. These were observed to bifurcate several times, and to send out rootlets in all directions into the clays or ancient soils in which they had grown. Such soils or underclays with Stigmaria afford more conclusive evidence of ancient terrestrial surfaces than even erect trees, as the latter might be conceived to have been drifted and fixed like snags in a river's bed. In the strata 1400 feet thick above mentioned, root-bearing soils were observed at sixty-eight different levels; and like the seams of coal which usually cover them, they are at present the most destructible masses in the whole cliff, the sandstones and laminated shales being harder and more capable of resisting the action of the waves and the weather. Originally the reverse was doubtless true; for in the existing delta of the Mississippi the clays in which innumerable roots of swamp trees, such as the deciduous cypress, ramify in all directions, are seen to withstand far more effectually the excavating power of the river or of the sea at the base of the delta, than do beds of loose sand or layers of mud not supporting trees.

This fact may explain why seams of coal have so often escaped denudation, and have remained continuous over wide areas, since the roots, now turned to coal, which once traversed them would enable them to resist a current of water, whilst other members of the coal formation, when in their original and unconsolidated state consisting of sand and mud, would be readily removed.

The upright trees usually enclose in their interior pillars of sandstone, or shale, or both these substances alternating, and these do not correspond in the thickness of their layers, or in their organic remains, with the external strata, or those enveloping the trunks. It is clear therefore that the trees were reduced while yet standing to hollow cylinders of mere bark, (now changed to coal,) into which the leaves of ferns and other plants with fragments of stems and roots were drifted, together with mud and sand during river inundations. The stony contents of one of

these trees, nine feet high and twenty-two inches in diameter, on being examined by Messrs. Dawson and Lyell, yielded, besides numerous fossil plants, some bones and teeth which they believed were referable to a reptile; but not being competent to decide that osteological question they submitted the specimens to Dr. Jeffries Wyman of Harvard University in the United States. That eminent anatomist declared them to be allied in structure to certain perennibranchiate batrachians of the genera Menobranchus and Menopoma, species of which now inhabit the lakes and rivers of North America. This determination was soon afterwards confirmed by Professor Owen of London, who pointed out the resemblance of some of the associated flat and sculptured bones, with the cranial plates, seen in the skull of the Archegosaurus and Labyrinthodon.* In the same dark-colored rock, Dr. Wyman detected a series of nine vertebræ, which from their form and transverse processes he regards as dorsal, and believes them to have belonged to an adult individual of a much smaller species, about six inches long, whereas the jaws and bones before mentioned are those of a creature probably two and a half feet in length. The microscopic structure of these small vertebræ was found by Professor Quekett to exhibit the same marked reptilian characters as that of the larger bones.

The fossil remains in question were scattered about the interior of the trunk near its base among fragments of wood now converted into charcoal, which may have fallen in while the tree was rotting away, having been afterwards cemented together by mud and sand stained black by carbonaceous matter. Whether the reptile crept into the hollow tree while its top was still open to the air, or whether it was washed in with mud during a flood, or in whatever other manner it entered, must be matter of conjecture. Foot-prints of two reptiles of different sizes have been observed by Dr. Harding and Dr. Gesner on ripple-marked flags of the lower coal measures in Nova Scotia, evidently made by quadrupeds walking on the beach, or out of the water, just as the recent Menopoma is sometimes observed to do. Other reptilian foot-prints of much larger size had been previously noticed (as early as 1844) in the coal of Pennsylvania by Dr. King; and in Europe three or four instances of skeletons of the same class of animals have been obtained; but the present is the first example of any of their bones having been met with in America in rocks of higher antiquity than the Trias. It is hoped however that other instances will soon come to light, when the contents of upright trees, so abundant in Nova Scotia, have been systematically explored; for in such situations the probability of discovering ancient air-breathing creatures seems greater than in ordinary

* Professors Wyman and Owen have named the reptile Dendrerpeton Acadianum, Acadia being an old name for Nova Scotia.

subaqueous deposits. Nevertheless we must not indulge too sanguine expectations on this head, when we recollect that no fossil vertebrates of a higher grade than fishes, or any land-shells, have yet been met with in the Oolitic coal-field of the James River, near Richmond, Virginia, a coal-field which has been worked extensively for three-quarters of a century. The coal alluded to is bituminous, and as a fuel resembles the best of the ancient coal of Nova Scotia and Great Britain. The associated strata of sandstone and shale contain prostrate zamites and ferns, and erect calamites and equiseta, which last evidently remain in the position where they grew in mud and sand. Whether the age of these beds be Oolitic as Messrs. W. B. Rogers and Lyell have concluded, or Upper Triassic as some other geologists suspect, they still belong clearly to an epoch when saurians and other reptiles flourished abundantly in Europe; and they therefore prove that the preservation of ancient terrestrial surfaces even in secondary rocks does not imply, as we might have anticipated, conditions the most favorable to our finding therein creatures of a higher organization than fishes.

In breaking up the rock in which the reptilian bones were entombed, a small fossil body resembling a land shell of the genus Pupa, was detected. As such it was recognized by Dr. Gould of Boston, and afterwards by M. Deshayes of Paris, both of whom carefully examined its form and striation. When parts of the surface were subsequently magnified 250 diameters, by Professor Quekett of the College of Surgeons, they were seen to exhibit ridges and grooves undistinguishable from those belonging to the striation of living species of land-shells. The internal tissue also of the shell displayed, under the microscope, the same prismatic and tubular arrangements which characterize the shells of living mollusca. Sections also of the same showed what may be part of the columella and spiral whorls, somewhat broken and distorted by pressure and crystallized. The genus cannot be made out, as the mouth is wanting. If referable to a pupa or any allied genus it is the first example of a pulmoniferous mollusk hitherto detected in a primary or palæozoic rock.

Sir Charles next proceeded to explain his views as to the origin of coal-fields in general, observing that the force of the evidence in favor of their identity in character with the deposits of modern deltas, has increased, in proportion as they have been more closely studied. They usually display a vast thickness of stratified mud and fine sand without pebbles, and in them are seen countless stems, leaves, and roots of terrestrial plants, free for the most part from all intermixture of marine remains, circumstances which imply the persistency in the same region of a vast body of fresh water. This water is also charged like that of a great river with an inexhaustible supply of sediment, which had usually been

transported over alluvial plains to a considerable distance from the higher grounds, so that all coarser particles and gravel were left behind. On the whole the phenomena imply the drainage and denudation of a continent or large island, having within it one or more ranges of mountains. The partial intercalation of brackish water-beds at certain points is equally consistent with the theory of a delta, the lower parts of which are always exposed to be overflowed by the sea even where no oscillations of level are experienced.

The purity of the coal itself, or the absence in it of earthy particles and sand throughout areas of very great extent, is a fact which has naturally appeared very difficult to explain if we attribute each coal-seam to a vegetation growing in swamps, and not to the drifting of plants. It may be asked how during river inundations capable of sweeping away the leaves of ferns, and the stems and roots of Sigillariæ and other trees, could the waters fail to transport some fine mud into the swamps? One generation after another of tall trees grew with their roots in mud, and after they had fallen prostrate and had been turned into coal were covered with layers of mud (now turned to shale), and yet the coal itself has remained unsoiled throughout these various changes. The Lecturer thinks this enigma may be solved, by attending to what is now taking place in deltas. The dense growth of reeds and herbage which encompasses the margins of forest-covered swamps in the valley and delta of the Mississippi, is such that the fluviatile waters in passing through them, are filtered and made to clear themselves entirely before they reach the areas in which vegetable matter may accumulate for centuries, forming coal if the climate be favorable. There is no possibility of the least intermixture of earthy matter in such cases. Thus in the large submerged tract called the "Sunk Country," near New Madrid, forming part of the Western side of the valley of the Mississippi, erect trees have been standing ever since the year 1811–12, killed by the great earthquake of that date; Lacustrine and swamp plants have been growing there in the shallows, and several rivers have annually inundated the whole space, and yet have been unable to carry in any sediment within the outer boundaries of the morass.

In the ancient coal of the South Joggins in Nova Scotia, many of the underclays show a network of Stigmaria roots, of which some penetrate into or quite through older roots which belonged to the trees of a preceding generation. Where trunks are seen in an erect position buried in sandstone and shale, rooted Sigillariæ or Calamites are often observed at different heights in the enveloping strata, attesting the growth of plants at several successive levels, while the process of envelopment was going on. In other cases there are proofs of the submergence of a forest

under marine or brackish water, the base of the trunks of the submerged trees being covered with serpulæ or a species of spirorbis. Not unfrequently seams of coal are succeeded by beds of impure bituminous limestone, composed chiefly of compressed Modiolæ with scales and teeth of fish, these being evidently deposits of brackish or salt water origin.

The lecturer exhibited a joint of the stem of a fresh water reed (*Arundinaria macrosperma*) covered with barnacles, which he gathered at the extremity of the delta of the Mississippi or the Balize. He saw a cane-brake (as it is called in the country) of these tall reeds killed by salt water, and extending over several acres, the sea having advanced over a space where the discharge of fresh water had slackened for a season in one of the river's mouths. If such reeds when dead could still remain standing in the mud with barnacles attached to them, (these crustacea having been in their turn destroyed by a return of the river to the same spot,) still more easily may we conceive large and firmly rooted Sigillariæ to have continued erect for many years in the Carboniferous Period, when the sea happened to gain on any tract of submerged land.

Submergence under salt water may have been caused either by a local diminution in the discharge of a river in one of its many mouths, or more probably by subsidence, as in the case of the erect columns of the Temple of Serapis, near Naples, to which Serpulæ and other marine bodies are still found adhering.

Sir Charles next entered into some speculations respecting the probable volume of solid matter contained in the carboniferous formation of Nova Scotia. The data he said for such an estimate are as yet imperfect, but some advantage would be gained could we but make some slight approximation to the truth. The strata at the South Joggins are nearly three miles thick, and they are known to be also of enormous thickness in the district of the Albion Mines near Pictou, more than one hundred miles to the eastward. There appears therefore little danger of erring on the side of excess, if we take half that amount or 7500 feet as the average thickness of the whole of the coal measures. The area of the coal-field, including part of New Brunswick to the west, and Prince Edward's Island and the Magdalen Isles to the north, as well as the Cape Breton beds together with the connecting strata which must have been denuded or must still be concealed beneath the waters of the Gulf of St. Lawrence, may comprise about 36,000 square miles, which with the thickness of 7500 feet before assumed will give 7,527,168,000,000,000 cubic feet (or 51,136·4 cubic miles) of solid matter as the volume of the rocks. Such an array of figures conveys no distinct idea to the mind; but is interesting when we reflect that the Mississippi would take more than two million of years (2,033,000 years) to

convey to the Gulf of Mexico, an equal quantity of solid matter in the shape of sediment, assuming the average discharge of water, in the great river, to be as calculated by Mr. Forshey, 450,000 cubic feet per second, throughout the year, and the total quantity of mud to be as estimated by Mr. Riddell, 3,702,758,400 cubic feet in the year.*

We may, however, if we desire to reduce to a minimum the possible time required for such an operation, (assuming it to be one of fluviatile denudation and deposition,) select as our agent, a river flowing from a tropical country, such as the Ganges, in the basin of which the fall of rain is much heavier, and where nearly all comes down in a third part of the year, so that the river is more turbid than if it flowed in temperate latitudes. In reference to the Ganges, also, it may be well to mention, that its delta presents in one respect a striking parallel to the Nova Scotia Coal-field, since at Calcutta at the depth of eight or ten feet from the surface buried trees and roots have been found in digging tanks, indicating an ancient soil now underground; and in boring on the same site for an Artesian well to the depth of 481 feet, other signs of ancient forest-covered lands and peaty soils have been observed at several depths, even as far down as 300 feet and more below the level of the sea. As the strata pierced through contained fresh-water remains of recent species of plants and animals, they imply a subsidence, which has been going on contemporaneously with the accumulation of fluviatile mud.

Capt. Strachey of the Bengal Engineers has estimated that the Ganges must discharge 4½ times as much water into the Bay of Bengal, as the same river carries past Ghazipore, a place 500 miles above its mouth, where experiments were made on the volume of water and proportion of mud by the Rev. Mr. Everest. It is not till after it has passed Ghazipore, that the great river is joined by most of its larger tributaries. Taking the quantity of sediment at one-third less than that assigned by Mr. Everest for the Ghazipore average, the volume of solid matter conveyed to the Bay of Bengal would still amount to 20,000 millions of cubic feet annually. The Ganges therefore might accomplish in three hundred and seventy five thousand years the task which it would take the Mississippi, according to the data before laid down, upwards of two million years to achieve.

One inducement to call attention to such calculations is the hope of interesting engineers in making accurate measurement of the quantity of water and mud discharged by such rivers as the Ganges, Brahmapootra, Indus, and Mississippi, and to lead geologists to ascertain the number of cubic feet of solid matter, which ancient fluviatile formations, such as the coal-measures, with their associated marine strata, may contain. Sir Charles

* See Principles of Geology, 8th ed., p. 19.

anticipates that the chronological results, derived from such sources, will be in harmony with the conclusions to which botanical and zoological considerations alone might lead us, and that the lapse of years will be found to be so vast as to have an important bearing on our reasonings in every department of geological science.

A question may be raised, how far the coöperation of the sea in the deposition of the Carboniferous Series might accelerate the process above considered. The Lecturer conceives that the intervention of the sea would not afford such favorable conditions for the speedy accumulation of a large body of sediment within a limited area, as would be obtained by the hypothesis before stated, namely, that of a great river entering a bay in which the waves, currents, and tides of the ocean should exert only a moderate degree of denuding and dispersing power.

An eminent writer, when criticising, in 1830 Sir Charles Lyell's work on the adequacy of existing causes, was at pains to assure his readers, that while he questioned the soundness of the doctrine he by no means grudged any one the appropriation of as much as he pleased of that "least valuable of all things, past time." But Sir Charles believes, notwithstanding the admission so often made in the abstract of the indefinite extent of past time, that there is, practically speaking, a rooted and perhaps unconscious reluctance, on the part of most geologists, to follow out to their legitimate consequences the proofs, daily increasing in number, of this immensity of time. It would therefore be of no small moment could we obtain even an approach to some positive measure of the number of centuries which any great operation of nature such as the accumulation of a delta or fluviatile deposit of great magnitude may require, inasmuch as our conceptions of the energy of aqueous or igneous causes or of the powers of vitality in any given geological period must depend on the quantity of time assigned for their development.

Thus, for example, geologists will not deny that a vertical subsidence of three miles took place gradually at the South Joggins, during the carboniferous epoch, the lowest beds of the coal of Nova Scotia like the middle and uppermost consisting of shallow-water beds. If then this depression was brought about in the course of three hundred and seventy-five thousand years it did not exceed the rate of four feet in a century, resembling that now experienced in certain countries where, whether the movement be upward or downward, it is quite insensible to the inhabitants, and only known by scientific inquiry. If, on the other hand, it was brought about in two millions of years according to the other standard before alluded to, the rate would be only six inches in a century. But the same movement taking place in an upward direction would be sufficient to uplift a por-

tion of the earth's crust to the height of Mont Blanc or to a vertical elevation of three miles above the level of the sea. In like manner, if a large shoal be rising, or attempting to rise, in mid-ocean at the rate of six inches or even four feet in a hundred years, the waves may grind down to mud and sand and readily sweep away the rocks so upraised as fast as they come within the denuding action of the waves. A mass having a vertical thickness of three miles might thus be stripped off in the course of ages, and inferior rocks laid bare. So in regard to volcanic agency a certain quantity of lava is poured out annually upon the surface, or is injected into the earth's crust below the surface, and great metamorphic changes resulting from subterranean heat accompany the injection. Whether each of these effects be multiplied by fifty thousand, or by half a million or by two million of years, may entirely decide the question whether we shall or shall not be compelled to abandon the doctrine of paroxysmal violence in ancient as contrasted with modern times. Were we hastily to take for granted the paroxysmal intensity of the forces above alluded to, organic and inorganic, while the ordinary course of nature may of itself afford the requisite amount of aqueous, igneous, and vital force, (if multiplied by a sufficient number of centuries,) we might find ourselves embarrassed by the possession of twice as much mechanical force and vital energy as we require for the purposes of geological interpretation.

ART. V.—*Reëxamination of American Minerals:* PART II—*Chesterlite; Loxoclase; Danbury Feldspars; Haddam Albite; Greenwood Mica; Biotite; Margarodite; Chesterlite Talc; Rhodophyllite; Cummingtonite; Hydrous Anthophyllite; Monrolite; Ozarkite; Dysyntribite; Gibbsite; Emerald Nickel:* by J. LAWRENCE SMITH, M.D., Professor of Chemistry in the University of Virginia, and GEORGE J. BRUSH, Ph. B., Assistant to the Chemical Department.

IN this Second Part of the reëxamination of American minerals, we include many other doubtful species—the results concerning them being presented below under their respective heads. It may be well to mention that no mineral is analyzed, the authenticity of which is not placed beyond the shadow of a doubt; and in many instances specimens of the same mineral have been obtained from different cabinets, they having been originally collected by different persons. These labors have been very much facilitated by many of the proprietors of the finest collections in this county, and in addition to those mentioned in our last paper, we would acknowledge our obligations to Professors Dana and Silliman, Jr., Mr. Wm. S. Vaux of Philadelphia, Messrs. Jenkins

and Horton of Monroe, N. Y., Professor Hume of Charleston, Mr. Markoe of Washington, and Mr. Samuel W. Johnson of the Yale Laboratory.

In the analytical processes, with the exception of the alkali determinations, we have deviated but little from the methods usually employed. In separating magnesia from alumina and iron where one or both of these exist in some abundance, the iron and alumina are separated by ammonia with the previous addition of sal-ammoniac, but the precipitate is redissolved and reprecipitated three times before the separation is considered satisfactory; in addition to this, the oxyd of iron and alumina are finally tested to ensure the absence of magnesia.

A reëxamination of some of the minerals here noticed may appear useless, as they have been considered by many mineralogists for some time past as no longer distinct species. The special object of the analyses here given is to remove as far as possible any existing doubts connected with them. Moreover, in continuation of these researches, we propose to enter upon the reëxamination of a number of well established species, in order, by additional analyses of them, to extend our knowledge of American minerals.

11. *Chesterlite, identical with Orthoclase.*

This mineral occurs in implanted crystals on dolomite near East Bradford, Chester County, Pa. In physical characters it resembles orthoclase, but it has been considered triclinic, and Erni's analysis* gave soda as the alkali. The crystals occur frequently as twins, and are often very much distorted—in specimens we have examined the angle T on T′ varies from 121° to 127°—rendering it extremely difficult to determine the normal value of the angle; some of the measurements would however lead to the conclusion that it is monoclinic, since the angle of cleavage is by our measurements near 90°. So far as our opinion is concerned—based on both its chemical and physical character—we unhesitatingly pronounce it an orthoclase.

Two analyses gave:

	1.	2.
Silica,	64·76	65·17
Alumina,	17·60	17·70
Peroxyd of iron,	·50	·50
Lime,	·65	·56
Magnesia,	·30	·25
Potash,	14·18	13·86
Soda,	1·75	1·64
Ignition,	·65	·65
	100·39	100·33

These correspond to the composition of orthoclase, and chemically the mineral is identical with it; if it shall be proved that the

* Dana's Mineralogy, 3d edit., p. 678.

crystalline form is triclinic, it will be a potash albite and as such, an interesting species.

The specimens examined were received from Messrs. T. F. Seal and Wm. S. Vaux of Philadelphia.

12. *Loxoclase, identical with Orthoclase.*

The feldspar associated with pyroxene at Hammond, N. Y., has been named as a distinct species by Breithaupt.* Its crystalline form, hardness, specific gravity and other physical characters, are the same as orthoclase, and the reasons for forming a new species of it are based upon its cleavage and chemical constitution. The latter Plattner found to be,

$\ddot{Si}$	$\dot{Al}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
63·50	20·29	0·67	3·22	*trace*	8·76	3·03	1·23 = 100·70

We have examined two varieties of it. Analyses 1 and 2 are from specimens taken from a large crystal and were not perfectly pure, owing to intimate association with a lime pyroxene; analyses 3 and 4 are from a very pure crystal.

	1.	2.	3.	4.
Silica,	65·40	65·69	66·09	66·31
Alumina,	19·48	20·72	19·15	18·23
Peroxyd of iron,	1·25			0·67
Lime,	2·26	2·36	·94	1·09
Magnesia,	·20	·25	·21	·30
Potash,	2·76	2·36	4·35	4·35
Soda,	7·23	7·98	7·81	7·81
Ignition,	·76	·76	0·20	0·20
	99·34	100·12	98·75	98·96

It will be seen at a glance that the only difference between this mineral and orthoclase is the large amount of soda, and in analyses 1 and 2 a small amount of lime, this last, most of which is doubtless an impurity, alters somewhat the oxygen ratios.

No. 1	gives . . .	1 : 3·10 : 11
2	. . . .	1 : 3 : 10·60
3	. . .	1 : 2·90 : 11·08
4	. . .	1 : 2·74 : 10·83

This slight difference in the ratio (produced by the presence of a considerable amount of soda) is not uncommon in orthoclase. In that from Hohenhagen, Schnedermann found 4·15 potash and 7·53 soda; the flesh-red feldspar from Bathurst, Canada, gave Hunt 6·36 potash, 5·37 soda, and Gmelin found in the feldspar from Laurvig, 6·55 potash and 6·14 soda, and in that from Fredicksvärn, 7·03 potash and 7·08 soda. These numbers affect to some slight extent the oxygen ratio, but the correspondence of the minerals in physical characters denotes their identity with orthoclase. Moreover, the identity of loxoclase with orthoclase is

* Pogg. Ann., lxvii, 419.

made obvious when we take the ratio between the silica and alumina, which in the purer varieties (analyses 3 and 4) is as 4 : 1, and analysis 4 gives the ratio 12 : 3·04 : 1·11, or $\dot{R}\ddot{S}i + \dot{R}\ddot{S}i^{8}$.

The specimens examined were received from Professor Silliman, Jr., and Mr. Samuel W. Johnson.

13. *Danbury Feldspars; 1. Oligoclase; 2. Orthoclase.*

1. *Oligoclase.*—The feldspar in which the Danburite occurs has so strong a resemblance to the oligoclase from Sweden that we have been led to analyze it; the results of our examination prove its identity with that species. The analyses gave:

	1.	2.
Silica,	64·03	63·50
Alumina,	22·37	22·75
Peroxyd of iron,	*trace*	*trace*
Lime,	2·91	3·28
Magnesia,	*trace.*	*trace*
Soda,	10·06	9·37
Potash,	·60	·50
Ignition,	·30	·21
	100·27	99·61

These give the oxygen ratio 1 : 3 : 9 and the formula $\dot{R}\ddot{S}i + \dot{A}l\ddot{S}i^{2}$, which are the ratio and formula for oligoclase.

2. *Orthoclase.*—There is also associated with Danburite a potash feldspar not unlike the soda feldspar just mentioned, in some cases it is so intimately associated with it as to require great care in selecting for analysis. So far as our observation extends, we have been able to identify the oligoclase by its occurrence in masses with a broad cleavage surface, and another less smooth, meeting at the angle 93°–94°; in orthoclase this angle is 90°, and most frequently it presents at this locality small cleavage faces and is sometimes of a granular structure.

The following analyses are of the latter variety, which doubtless contain a little oligoclase that it is impossible to separate.

	1.	2.
Silica,	63·80	63·95
Alumina,	18·90	19·05
Lime,	·80	·61
Magnesia,	·20	·20
Potash,	11·43	10·95
Soda,	3·86	3·69
Ignition,	·30	·50
	99·29	98·95

The specimens examined were taken from the locality by one of the authors.

14. *Haddam Albite, identical with Oligoclase.*

Associated with the iolite at Haddam, Conn., there occurs a glassy feldspar which has heretofore been called albite. Its com-

position is that of an oligoclase, as will be seen by the following analyses:

	1.	2.
Silica,	63·87	64·64
Alumina,	21·82	21·98
Lime,	2·14	2·17
Magnesia,	*trace*	*trace*
Soda,	10·18	9·80
Potash,	·50	·50
Ignition,	·29	·29
	98·80	99·38

The specimens examined were received from Prof. Dana.

We have examined the *moonstone feldspar*, from Mineral Hill, Delaware Co., Pa., which is also oligoclase.

15. *Greenwood Mica—Biotite.*

The chemical constitution of only a very few American biotites has been examined. In fact, von Kobell's* analysis of a mica from Monroe, N. Y., is the only one that has been published; unfortunately, even in regard to this, there is some doubt as to its locality, for biotite is found in more than one place near Monroe.

The specimens we have examined are from Greenwood Furnace, Monroe, N. Y.; the mineral occurs in large crystals of a dark olive green color, and the results of the analyses are such as to lead to the supposition that the specimens examined by von Kobell were from this locality. He obtained:

Sï	Äl	Fe̋	Mg̈	K̇	HF	Ti̇	Ḣ
40·00	16·16	7·50	21·54	10·83	0·53	0·20	3·00=99·76

The results of our analyses are:

	1.	2.
Silica,	39·88	39·51
Alumina,	14·99	15·11
Peroxyd of iron,	7·68	7·99
Magnesia,	23·69	23·40
Potash,	9·11	10·20
Soda,	1·12	
Water,	1·30	1·35
Fluorine,	·95	·95
Chlorine,	·44	·44
	99·16	98·95

These give the oxygen ratio:

	Ṙ	R̈	Sï
1.	11·31	9·31	20·72
2.	11·20	9·45	20·53

or very nearly 1 : 1 : 2, which corresponds to the formula

$$\dot{R}^3\,\ddot{S}i + \ddot{R}\,\ddot{S}i.$$

A small portion of the oxygen in the mineral is replaced by fluorine and chlorine.

The specimens examined were received from Messrs. Jenkins & Horton, of Monroe, N. Y.

* J. f. pr. Chem., xxxvi, 309, and Dana's Mineralogy, 3d edit., page 360.

16. *Biotite of Putnam Co., N. Y,*

In appearance this mineral resembles talc, having a wavy, lamellar structure, and a soapy feel. Its color is brownish green in mass, and pale yellowish green by transmitted light. Hardness 2–2·5. Sp. Gr. 2·80. The laminæ are entirely devoid of elasticity. It has been called pyrophyllite by some mineral collectors, but upon what grounds we are ignorant, as it does not possess the remarkable property of exfoliating and swelling up by heat, so peculiar to pyrophyllite. Analysis shows its composition to be identical with Biotite.

	1.		2.
Silica,	39·62		39·49
Alumina,	17·35		17·06
Peroxyd of iron,	5·40		5·21
Magnesia,	23·85		23·65
Potash,	8·95		——
Soda,	1·01		——
Water,	1·41		——
Fluorine,	1·20		——
Chlorine,	·27		——
	99·06		

$\dot{R}$ $\ddot{R}$ $\ddot{Si}$

Analysis 1 gives oxygen ratio 11·22 : 9·73 : 20·58, or 1 : 1 : 2, and the same formula as for the mineral last mentioned, $\dot{R}^3\ddot{Si}+\ddot{R}\ddot{Si}$.

The specimens examined were received from Mr. Silas R. Horton, of Craigville, New York.

17. *Margarodite.*

This mineral occurs at Lane's Mine, Monroe, Conn. It has been analyzed by W. H. Brewer,* but owing to some impurities in his specimens, he obtained an excess of silica.

Specimens very carefully selected, to avoid the fluor spar, and other minerals with which it is associated, gave:

	1.		2.
Silica,	46·50		45·70
Alumina,	33·91		33·76
Peroxyd of iron,	2·69		3·11
Magnesia,	·90		1·15
Potash,	7·32		7·49
Soda,	2·70		2·85
Water,	4·63		4·90
Fluorine,	·82		·82
Chlorine,	·31		·31
	99·78		100·09

These correspond to the analysis of margarodite from St. Etienne, in which Delesse found,

$\ddot{Si}$	$\ddot{Al}$	$\ddot{Fe}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$	Fl	
46·23	33·08	3·48	2·10	1·45	8·87	4·12	*trace*	=99·33

In a former paper we have mentioned the difficulty of obtaining a correct formula from the analyses of margarodite, owing to

* Dana's Mineralogy, 3d edit., p. 359.

slight differences in the protoxyds. The relation of the oxygen of the silica to that of peroxyds in most of the analyses, is as 3 : 2.

The specimens examined were received from Prof. Silliman, Jr.

18. *The Chesterlite Talc—a Mica.*

Associated with the Chesterlite, a micaceous mineral is found, which has been called talc. It occurs in implanted crystals, in minute tuft-like aggregations on dolomite, there is frequently an iron stain upon the surface, due to the decomposition of some of the minerals with which it is associated, the crystals are seldom over a line in diameter. Its chemical composition is that of a mica, but owing to the small amount examined it is impossible to say positively whether it be muscovite or margarodite, although from its association we are inclined to consider it muscovite.

Silica,	45·50
Alumina,	34·55
Peroxyd of iron,	*trace*
Lime,	2·31
Magnesia,	1·08
Potash,	8·10
Soda,	2·35
Water and carbonic acid,	5·40
	99·29

A large portion of the lime and magnesia is doubtless due to the dolomite with which it is associated.

The specimen was received from Mr. Thos. F. Seal.

19. *Rhodophyllite, identical with Rhodochrome.*

The violet colored mineral which occurs at Texas, Pa., and was circulated among mineralogists as "violet talc," has been analyzed by Dr. Genth,* of Philadelphia, who found for it a distinct composition, and gave it the above name. Its physical characters correspond with Rhodochrome and Kammererite, but as there had been no analysis published of the first, and as Dr. Genth's results did not agree with those obtained for Kammererite, he doubtless felt himself justified in considering it a new species. A short time after his results appeared, an analysis of rhodochrome was published by Hermann; its identity with those of rhodophyllite induced us to reëxamine the latter.

The results on two analyses are:

	1.	2.
Silica,	33·26	33·30
Alumina,	10·69	10·50
Sesquioxyd of chromium,	4·78	4·67
Peroxyd of iron,	1·96	1·60
Magnesia,	35·93	36·08
Soda and Potash,	·35	·35
Water,	12·64	13·25
	99·61	99·75

* Proc. Acad. Nat. Sci. Phil. vi, 122.

These will be seen to correspond with the analyses (1, 2) of Rhodophyllite by Dr. Genth, and the analysis of rhodochrome (3) and chrome chlorite (4), by Hermann.

	Si	Al	Fe	Cr	Ni	Mg	Ca	Li Na	K	H
1. Texas, Pa.	33·41		18·15		*trace*	35·86	*trace*	0·28	0·10	12·79
2. " "	32·98	11·11	1·43	6·85	*trace*	35·22	*trace*	0·28	0·10	13·12
3. L. Itkul,	34·64	10·50	2·00	5·50	——	35·47	——	——	——	12·03
4. Texas, Pa.	31·82	15·10	4·06	0·90	0·25	35·24	——	——	——	12·75

Our analyses give the formula, $4\dot{R}^3\ddot{S}i+\dot{R}^2\ddot{S}i+10H$.

Dr. Genth gives the same formula minus one atom of water. The amount of oxyd of chromium varies in different specimens and to this is due the various shades of color. Dr. Genth informs us that he observed a like variation in the specimens he examined. The chrome-chlorite examined by Hermann was undoubtedly one of the light colored varieties.

Nickel as well as lime is found in some specimens, but both are impurities; the nickel is due to small particles of sulphuret of nickel which occurs at the same locality, and in many instances is disseminated through this mineral; in some specimens these impurities are not readily detected by the eye. In all probability the carbonate and silicates of nickel found on the Texas chrome iron proceed from the decomposition of this sulphuret.

Mr. T. H. Garrett* has recently given an analysis of this mineral. His results differ materially from those obtained above.

20. *Cummingtonite—a Hornblende.*

This mineral was described by Dewey,† and analyzed by Muir.‡ The latter obtained for its composition,

Si	Fe	Mn	Na	H
56·54	21·67	7·80	8·44	3·18=97·63

Authentic specimens for examination were procured from the Lederer collection in Yale College. Its structure is fibrous, resembling anthophyllite; lustre silky; color ash gray. It occurs in mica slate at Cummington, Mass.

Two analyses gave:

	1.	2.
Silica,	51·09	50·74
Alumina,	·95	·89
Protoxyd of iron,	32·07	33·14
Magnesia,	10·29	10·31
Manganese,	1·50	1·77
Lime,	*trace*	*trace*
Soda,	·75	·54
Potash,	*trace*	——
Water,	3·04	3·04
	99·69	100·43

* This Journal, May, 1853.

† This Journal, [1] viii, 59.

‡ Thomson's Min., i, 493.

These give the formula, $(\dot{F}e\,\dot{M}g)^4\,\ddot{S}i^3 = \dot{R}^3\,\ddot{S}i^2 + \dot{R}\,\ddot{S}i$.

	Atoms.	At. weight.	Per cent.	Oxygen ratio.
Silica,	3	1731·93	53·59	3
Protoxyd iron,	$2\frac{1}{3}$	1125·09	34·80	$1\frac{1}{3}$
Magnesia,	$1\frac{1}{2}$	375·00	11·61	

This is the chemical constitution of hornblende, and from its physical characters it was long since referred to this species.

21. *Hydrous Anthophyllite—an Asbestus.*

Thomson gave this name to an asbestiform mineral, which is found associated with chlorite on New York Island.* His analysis gives:

$\ddot{S}i$	$\dot{M}g$	$\dot{F}e$	$\dot{M}n$	$\dot{K}$	$\dot{A}l$	$\dot{H}$
54·98	13·38	9·83	1·20	6·80	1·56	11·45 = 99·20

We have received undoubted specimens of this mineral from Messrs. Vaux, of Philadelphia, and Silas R. Horton, of New York. The asbestiform mineral, carefully freed from the chlorite and other impurities, gave on two analyses:

	1.	2.
Silica,	58·20	58·47
Magnesia,	28·96	29·71
Protoxyd iron,	8·46	9·06
Soda,	·88	·88
Potash,	*trace*	*trace*
Ignition,	2·26	2·26
Alumina,	*trace*	*trace*
	98·76	100·38

These correspond to the formula, $\dot{R}^4\,\ddot{S}i^3$ or $\dot{R}^3\,\ddot{S}i^2 + \dot{R}\,\ddot{S}i$.

	Atoms.	At. weight.	Per cent.	Oxygen ratio.
Silica,	3	1732·00	61·16	3
Magnesia,	$3\frac{1}{4}$	875·00	30·90	$1\frac{1}{4}$
Protoxyd iron,	$\frac{1}{4}$	225·00	7·94	

This is the formula given for the last mineral, and the composition is that of an asbestus or magnesian hornblende.

22. *Monrolite, identical with Kyanite.*

This mineral was described by Professor Silliman, Jr.† as a hydrous silicate of alumina resembling Wœrthite. Prof. Silliman, however, observes that the water varied in several specimens examined from 3·09 to 1·84 per cent.; subsequent examinations‡ made by one of us showed that the water in the pure mineral was not over one per cent.

In the analysis recently made, we find that the silica and alumina are the same as in kyanite, and that the high silica obtained by the analyst quoted, was undoubtedly owing to the impurity of the mineral, as a careful examination with the magnifier shows plates of quartz interlaced with almost every specimen. The re-

* Thomson's Mineralogy, i, 209.
† This Journal, [2] viii, 385.
‡ Dana's Mineralogy, 3d edit., p. 317.

sults of analysis on specimens carefully selected to avoid the quartz, gave

	1.		2.
Silica,	37·20		37·03
Alumina,	59·02		61·90
Peroxyd of iron,	2·08		
Ignition	1·03		·85
	99·33		99·78

These correspond to the formula $\ddot{Al}^3\ddot{Si}^2$.

23. *Ozarkite, an amorphous Thomsonite.*

This mineral was described by Professor Shepard as a new species.* It occurs in irregular veins and masses in Elæolite at Magnet Cove, Arkansas.

We are indebted to Mr. Markoe of Washington, for a large quantity of the Elæolite from which we were able to obtain the mineral in a pure state. Its color is white, structure granular to compact. Hardness 5; Sp. Gr. 2·24 (Shepard). Gelatinizes with hydrochloric acid.

Two analyses gave,

	1.		2.
Silica,	36·85		37·08
Alumina,	29·42		31·13
Peroxyd of iron,	1·55		
Lime,	13·95		13·97
Soda,	3·91		3·72
Water,	13·80		13·80
	99·48		99·70

This is the composition of Thomsonite, and the mineral is a massive variety of that species.

The analyses give the formula $\dot{R}\ddot{Si}+3\ddot{Al}\ddot{Si}+7\dot{H}$ = Silica 37·8, alumina 31·5, lime 13·00, soda 4·80, water 12·90.

Special examination was made for phosphoric acid, but in the pure mineral none could be found, although in some impure specimens that one of us had previously examined,† it existed in the form of Apatite in considerable abundance, and the specimens examined were pronounced a mixture of apatite and a zeolite.

This mineral was first referred to the zeolites by Mr. J. D. Whitney,‡ who on a qualitative analysis found it to be a hydrous silicate of alumina and lime, with a little soda.

24. *Dysyntribite, a rock of indefinite composition.*

The substance to which the above name was given by Prof. Shepard,§ occurs in large masses in the Northern part of the State of New York. It is of a green color, sometimes mottled

* Am. Jour. Science, [2] ii.
† This Journal, [2] ix, 439.
‡ Jour. Bost. Soc. Nat. Hist., 1840, p. 42.
§ Rep. Amer. Assoc. Advan. Sci., vol. iv, 311.

with red. It resembles serpentine, but has a strongly argillaceous odor when moistened.

Having reason to suspect that the substance was not perfectly homogeneous—from our first analysis not agreeing with Prof. Shepard's,—various specimens were examined. The correctness of the supposition will be seen by comparing the following results.

	1.		2.	3.		4.	
Silica,	44·80	44·77	44·94	46·70	46·60	44·74	44·10
Alumina,	34·90	35·88	25·05	31·01	35·15	20·98	20·64
Iron,	3·01	2·52	3·33	3·69		4·27	4·03
Manganese,	·30	·30	*tr.*	*tr.*	*tr.*	*tr.*	
Lime,	·66	·52	8·44	*tr.*	*tr.*	12·90	12·34
Magnesia,	·42	·53	6·86	·50	·50	8·48	8·57
Potassa,	6·87	——	5·80	11·68	11·68	3·73	3·92
Soda,	3·60	——	*tr.*	*tr.*	——	*tr.*	——
Water,	5·38	4·72	6·11	5·30	5·30	4·86	6·30
	99·94		100·53	98·88	99·13	99·96	99·90

There is a remarkable agreement in the per-centages of silica. The mineral was found to lose about 2 per cent. of water by desiccation. Some specimens showed the presence of a small amount of phosphoric acid. Nos. 1 and 4 were received from Mr. S. W. Johnson, No. 2 from Mr. Silas R. Horton, and the exact locality of it is Diana, N. Y., No. 3 was received from Prof. Hume of Charleston, who obtained it from Prof. Shepard.

The original analysis by Prof. Shepard gave,

$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{H}$	$\dot{C}a$ $\dot{M}g$
47·68	41·50	5·48	4·83	*traces*

This substance bears a close relation to agalmatolite, which from the variable proportion of its constituents, cannot be considered a mineral but is a rock. Some of the specimens of dysyntribite give the composition of Pinite, but it is reasonable to suppose, that a mineral varying so much in its alumina, magnesia, lime and alkalies, may in different masses furnish a resemblance to a vast number of minerals.

25. *Gibbsite.*

Gibbsite was first described by Dr. Torrey * as hydrate of alumina. This composition, confirmed by Dewey and Thomson, was considered correct, until Hermann† announced the discovery of over 37 per cent. of phosphoric acid in it, and that the mineral was a hydrous phosphate of alumina. To satisfy all doubts in this matter, Prof. Silliman, Jr.,‡ examined it with direct reference to the occurrence of phosphoric acid, and in none of the specimens examined, could he find more than a trace. Subsequently Mr. Crossley,§ of Boston, analyzed it, and his results confirmed the previous analyses of American chemists; meanwhile Hermann‖

* N. Y. Med. and Phys. Journal, i, 68.
† J. f. pr. Chem., xl, 32.
‡ This Jour., [2] vii, 411.
§ This Jour., [2] ix, 408.
‖ J. f. pr. Chem., xlvii, 1.

reëxamined it, and found the phosphoric acid to vary in different specimens from 37·62 to 11·90 per cent.—showing that he had not obtained a homogeneous mineral.

Considerable pains have been taken to obtain a number of authentic specimens for examination, some of which are direct from the locality, and others from our own collection. The results show that the mineral is a hydrate of alumina, ($\dot{A}l\,H^3$) with but a *trace* of phosphoric acid, and in some specimens not even a trace existed.

Two analyses gave,

	1.	2.
Alumina,	64·24	63·48
Peroxyd iron,	*trace*	*trace*
Water,	33·76	34·68
Silica,	1·33	1·09
Phosphoric acid,	·57	*trace*
Magnesia,	·10	·05
	100·00	99·30

The phosphoric acid was determined by molybdate of ammonia; the small amount of silica is due to the intimate mixture of the mineral with allophane. From the results of these examinations, we are confident that Mr. Hermann has not at any time analyzed pure Gibbsite.

26. *Emerald Nickel.*

We notice in the last edition of Phillip's Mineralogy, that Prof. Miller and Brooke place this species among the doubtful ones, without however giving any reasons for so doing. To ascertain if any good reason existed for this doubt, we have reänalyzed it, and find the same composition as given by Prof. Silliman, Jr.,* which was,

Oxyd Nickel.	Carbonic Acid.	Water.
58·81	11·69	29·49

We obtained,

		Oxygen
Oxyd of nickel,	56·82	12·10
Magnesia,	1·68	·67
Carbonic acid,	11·63	8·46
Water,	29·87	26·56

which gives the formula, $\dot{N}i^3\,\ddot{C}+6\dot{H}$.

	Atoms.	At weight.	Per cent.	Oxygen ratio.
Oxyd nickel,	3	1408	59·72	3
Carbonic acid,	1	275	11·66	2
Water,	6	675	28·62	6

We would prefer expressing its formula by an atom of carbonate of Nickel plus two atoms of the hydrated oxyd of nickel; this is rendered probable from the fact, that whenever it is attempted to form a carbonate of the protoxyd of nickel, by precipitating a protosalt with an alkaline carbonate, a carbonate is obtained,

* This Journal, [2] vi, 248.

containing a certain amount of the hydrated oxyd—for these reasons, we would express emerald nickel by $\dot{N}i\,\ddot{C}+2(\dot{N}i\,H_3)$.

It is without question a distinct species, and a most beautiful and interesting mineral, both from the richness of its color and its association with chromic iron.

Since completing our examinations of this mineral, we have observed an analysis of a mineral called emerald nickel, by Mr. T. H. Garrett.* The mineral examined was of a very impure description, and was supposed by the analyst to be a mixture of emerald nickel, meerschaum and augite; of course, it is impossible to furnish any correct idea of the composition of *pure* emerald nickel, from results on such impure specimens. This mineral is often associated more or less intimately with a nickel serpentine, or gymnite, but with an abundance of the mineral to select from, a hydrous carbonate of nickel can be obtained of a uniform composition; a quarter of an ounce of selected fragments sent by Mr. L. White Williams, furnished us with about one gramme of the pure mineral.

University of Virginia, May 6th, 1853.

ART. VI.—*New and ready method of determining the Alkalies in Minerals:* PART II—*Conversion of the Sulphates into Chlorids: Qualitative Determination of the mixed Alkalies: Separation of the Alkaline Chlorids from each other, with a more direct method of obtaining them from silicates not soluble in Acids;* by J. LAWRENCE SMITH, Professor of Chemistry in the University of Virginia.

Conversion of the Sulphates into Chlorids.

31. In continuation of the subject, the next point to be considered is the conversion of the sulphates of the alkalies into chlorids. The method ordinarily adopted to accomplish this change, is to precipitate the sulphuric acid by means of chlorid of baryum, care being taken to avoid the slightest excess of the latter. The annoyance attendant upon this exact precipitation, is familiar to all who may have had occasion to make the trial.

32. Instead of the chlorid of baryum, the acetate of lead is used: a solution of this salt is poured in excess upon the solution of sulphates, warming the latter slightly, the sulphate of lead readily separates, the whole can be immediately thrown on a filter and washed—a drop or two of the acetate of lead should be added to the filtrate, to insure there being an excess of the lead salt.

33. The filtrate is then warmed and sulphuretted hydrogen added—care must be taken to see that there is an excess of sul-

* This Journal, May, 1853.

phuretted hydrogen, a test most readily performed by means of a piece of lead paper. The liquid is thrown on a filter to separate the sulphuret of lead; the filtrate containing the alkalies as acetates, is evaporated, and when nearly dry, an excess of hydrochloric acid is added, and the whole evaporated to dryness over a water-bath, and finally heated to above 500°. A hot solution of the chlorid of lead can be used instead of the acetate, rendering the addition of hydrochloric acid unnecessary.

34. It needs but little experience to convince one of the superiority of this method, over that by the chlorid of baryum, for converting the sulphates into the chlorids, its principal recommendation being the indifference with which an excess of the lead salt can be added, to precipitate the sulphuric acid, and the subsequent facility with which that excess of lead can be got rid of. It may be well to state, that experiments were made to prove the perfect precipitation of the sulphuric acid from the sulphates of the alkalies by the salts of lead, and it is only after numerous comparative results, that it is now recommended.

To distinguish the Alkalies from each other when mixed.

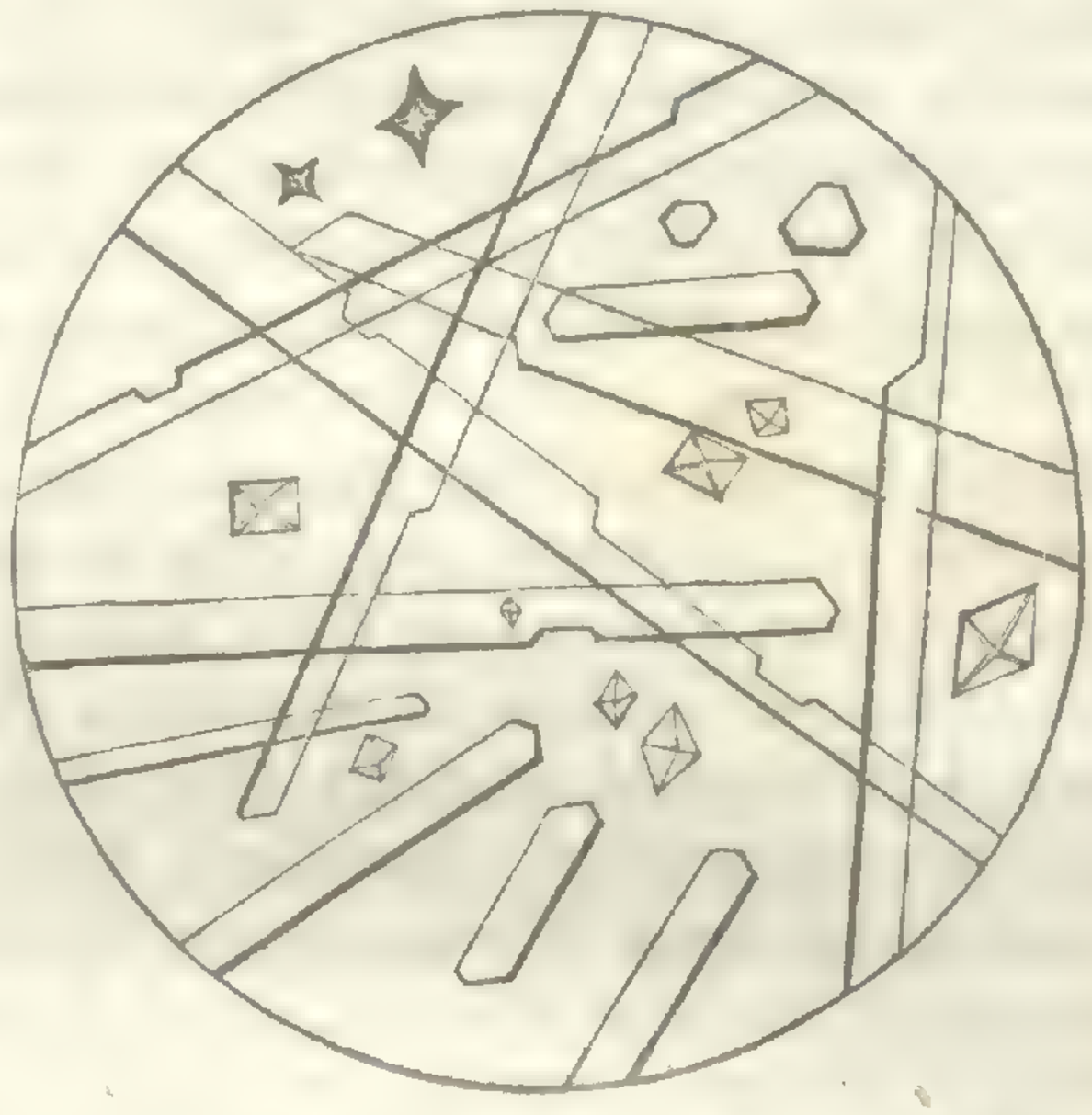
35. To distinguish potash, soda and lithia when mixed, is attended with more or less difficulty, according to the proportions in which they are mixed; of the three, potash is the most easily recognized, next in order is soda, and lastly lithia; the presence of which, mixed in small amount with proportionally large quantities of the other alkalies, it is almost impossible to decide on with any accuracy, without direct separation.

36. In the analysis of many minerals, the characters of which lead to the supposition of the presence of the alkalies, it is useless to precede the quantitative determination by one of a qualitative character, especially as the steps to be followed to separate the alkalies are the same in both cases, and to proceed in this way, is economy of time. From my own experience concerning the constitution of the silicates, there are doubtless but a very few of them without an appreciable quantity of alkalies in their constitution; and an easy method to examine with certainty the composition of such small quantities of alkaline chlorids must add to our analytical knowledge. With a little experience, the method about to be described will be found very available.

37. To ascertain the nature of the alkalies present in the chlorids before proceeding to separate them, we abstract a quantity so small as not sensibly to affect the weight of the mass. The smallest piece of the dried mass that need not exceed $\frac{1}{50}$ of an inch in diameter, is placed on a slip of glass, and to it is added a drop of a watery solution of *very pure* chlorid of platinum,* not too concentrated, and the plate gently warmed; if potash be present

* The alcoholic solution does not give perfect results and should not be used.

a yellow deposit soon takes place, which by the microscope will be seen to consist of octahedral crystals of the double chlorid of potash and platinum: the evaporation should be continued very gently with a heat not exceeding 120° to 130° until the liquid begins to dry on the edge; if this be now examined under the microscope, and soda be present, beautiful needle-shaped crystals will be seen, both formed and forming, with an oblique angle of termination, the crystals frequently having reëntering angles as represented in the figure. The border of liquid on the glass is the place to observe these crystals, and that, while the process of drying is going on. When the amount of soda is very small, it is best to allow the solution on the glass to dry in the slowest possible manner. Should the quantity of soda be still smaller or the nature of the crystals doubtful, resort may be had to polarized light, when the prismatic crystals of chlorid of platinum and sodium will be at once rendered visible by their beautiful colors, as they possess polarizing properties, whereas the crystals of chlorid of platinum and potassium, besides differing in form, do not polarize light.



38. This method of detecting a small quantity of soda in the presence of potash, I have employed since June, 1850, while engaged in the examination of the collection of urinary calculi belonging to the Dupeytren museum at Paris; at that time, it was employed daily in the laboratory of Messrs. Wurtz and Verdeil: the special reason for devising it was to examine the nature of the trace of alkali almost invariably found in the uric acid calculi after combustion.

39. The reason for making special reference to the date of the original employment of this method, is to claim priority in its use, as Mr. Andrews announces it in a late number of the Chemical Gazette as a new method. Were not the method so well known and so constantly employed in the laboratory of Wurtz and Verdeil at the period above mentioned, I should not now set up any reclamation in the matter.

40. The amount of soda that can thus be detected, is exceedingly small, as the liquid can be concentrated to the very smallest bulk. When the amount of potash is proportionally large compared with that of the soda, it is better to put the chlorid of platinum in a drop of the solution of the alkaline chlorids placed

in a watch glass, allow the potash salt to settle, take a little of the clear liquid, place it on a slip of glass, evaporate slowly, and examine in the way already mentioned. We should avoid the use of alcohol as a solvent for the salts employed.

41. For the full appreciation of this method it requires some experience, and on first trials the extreme results will not be readily obtained; too much care cannot be taken with reference to the evaporation, sometimes if the evaporation be a little too speedy, no indication of the presence of soda will be evinced—so, in all doubtful instances, the glass should be laid aside for an hour or two, when the excess of the chlorid of platinum will attract moisture from the air and afford an opportunity for the chlorid of platinum and soda to crystallize regularly. For the most perfect success in very minute quantities of soda, too great an excess of chlorid of platinum should be avoided. Those engaged in mineral analysis, who will employ this means of detecting the presence of the alkali, will find it of great assistance in facilitating their labors, especially when directed to very minute accuracy in their results, for I have reason to believe it rare to find in minerals any one of the alkalies perfectly free from one of the others.

42. When the chlorid of lithium is present, it interferes materially with this method of detecting small amounts of soda, for owing to its very deliquescent nature, it abstracts moisture from the air, and dissolves the double chlorid of sodium and platinum, or prevents altogether its formation into recognizable crystals. These investigations have added nothing to what is already known concerning the detection of lithia mixed with soda and potash; the plan invariably adopted, is to treat the mixed chlorids with a solution of alcohol and ether, and examine the part dissolved, by the blowpipe; details as to the manner of using the alcohol and ether solution are given under the next head.

Separation of the Alkalies from each other.

43. Under this head I have nothing to add to what is already known on the subject: it may be well, however, to mention the manner in which Rammelsburg's method of separating lithia has been employed, as it has not yet been fairly tested in this country. His method, it is well known, is based on the solubility of the chlorid of lithium in a mixture of equal parts of absolute alcohol and ether, neither of the other chlorids being dissolved by this menstruum. A number of experiments were made on known quantities of the alkalies, and the results of some of them are as follows:

a. 500 milligrm. chlorid of potassium treated with the mixture of ether and alcohol, ten grammes of the latter being used, yielded only $\frac{3}{10}$ of a milligramme to the liquid.

b. 500 milligrm. of chlorid of sodium treated in the same way yielded ½ milligramme to the liquid.

c. A mixture of chlorids of potassium, sodium and lithium, in which the latter constituted 2 per cent. of the mass, was acted on by the ether and alcohol, filtered and evaporated to dryness; the residue was equal to 2·53 per cent. The quantity used, was Cl K and Cl Na each 200 milligrm., Cl Li ·8 milligrams.

d. A similar mixture containing 18·10 per cent. of chlorid of lithium, furnished a residue of 17·65 per cent.

e. A similar mixture containing 67·20 per cent. chlorid of lithium, gave a residue of 68·40

44. By these results it may be seen that this method of separating lithia from the other alkalies may be perfectly relied on. It only remains to detail the precautions to be taken in order to ensure accurate results.

45. The solution of alcohol and ether must be made of absolute alcohol mixed with its volume of pure ether. The chlorids must be dried thoroughly at 212° or a little above; if they have at any time been heated much higher, a drop or two of hydrochloric acid must be added to the chlorids, that are subsequently dried at the temperature just mentioned. The desiccation is best carried on in a small sized capsule. To the dry mass, a small quantity of the mixture of alcohol and ether is added, and stirred with a small glass rod, the chlorids soon disintegrate; the capsule and its contents are placed on a glass plate, and covered with a small bell glass; (a common tumbler answer the purpose very well, especially if the edge be ground,) this is left to digest for twenty-four hours, and then thrown on a filter and washed with the *alcohol ether* solution, the chlorids of sodium and potassium remain on the filter. These last can be dissolved off the filter by means of water, and separated in the ordinary way.

46. The alcohol-ether solution of chlorid of lithium is evaporated to dryness, converted into sulphate and weighed. The results thus obtained far exceed in accuracy those from any other method for separating lithia. The indirect method, by ascertaining the quantity of sulphuric acid contained in the mixed sulphates, is the next best, but like all indirect methods of analysis, should never be employed except when it is absolutely necessary.

47. When the alkalies are presented in the form of chlorids before their quantity has been estimated in some other form, it is best to proceed first to the separation of lithia, afterwards weigh the chlorids not dissolved by the *alcohol-ether*, and lastly, separate the potash chlorid from the soda chlorid, if both be present, by means of the bichlorid of platinum. Experiments were made with a mixture of alcohol and chloroform, the results

of which were not as satisfactory as those afforded by the alcohol-ether.

Substitution of Chlorid of Ammonium for Fluorid of Calcium, to mix with Carbonate of lime to decompose the silicates.

48. It was mentioned in the previous paper on this subject how carbonate of lime could be rendered as powerful in its decomposing agency on the silicates as caustic potash, the effect being due to the use of some flux, fluorid and chlorid of calcium being used for that purpose. I have since tested more carefully the merits of the chlorid of calcium, and for various reasons prefer it to the exclusion of the fluorid. In the first place it introduces chlorine instead of fluorine into the analysis, and secondly, the fusion is more easily detached from the crucible, and dissolved by hydrochloric acid.

49. The manner of introducing the chlorid of calcium into the mixture of mineral and carbonate of lime was a point of some little importance, as from the deliquescent nature of that compound it was inconvenient to weigh and mix it with the carbonate of lime and mineral; these difficulties are obviated by employing *chlorid of ammonium* to form indirectly the chlorid of calcium.

50. The process which appears to leave hardly any thing to desire, is to take *one part of the finely pulverized mineral, five to six of carbonate of lime, and one-half to three-fourths of chlorid of ammonium*,* mix them intimately in a glazed mortar, introduce the mixture in a platinum crucible, heat to bright redness in a furnace† from thirty to forty minutes.

51. There is no silicate which after having undergone this process, is not easily dissolved by hydrochloric acid. For the action of the lime to have been complete, it is not necessary that the mass should have settled down in perfect fusion. The contents of the crucible are dissolved, and the analysis continued as pointed out in 19, 20, 21, &c.

52. This method insures the obtaining of every particle of the alkalies in the mineral examined, requiring no more precaution than any good analyst is expected to take in the simplest of his processes, and not the least of the advantages, is the ready method of separating all the other ingredients and the small accumulation of water arising from the little washing necessary.

* The chlorid of ammonium is best obtained in a pulverulent condition, by dissolving some of the salt in hot water, and evaporating rapidly; the greater portion of the chlorid of ammonium will deposit itself in a pulverulent condition, the water is poured off, and the salt thrown on bibulous paper, allowed to dry; the final desiccation being carried on in a water-bath, or in any other way with a corresponding temperature.

† An ordinary portable furnace with a conical sheet-iron cap of from two to three feet high, answer the purpose perfectly well, all the requisite heat being afforded by it.

A more speedy method of separating the Alkalies directly from the lime fusion for both qualitative and quantitative determination.

53. As soon as the fusion with carbonate of lime and sal-ammoniac, gave evidence of the mineral being so thoroughly attacked, the question naturally arose as to the condition the alkalies were in after the fusion, and the possibility of dissolving them out by the agency of water alone, at least for the purpose of qualitative determination. Experiments directed to this object soon made it evident that the alkalies might be obtained from any silicate, without resorting to the use of acid as a solvent for the fusion.

54. The mass as it comes from the crucible, is placed in a capsule with water, and then heated in a sand-bath or over a lamp for two or three hours, renewing the water from time to time as it evaporates. The mass disintegrates very shortly after being placed in the water. The contents of the capsule are next thrown on a filter, and the water passes through containing the chlorid of the alkalies, a little chlorid of calcium and caustic lime, all else that the mineral may have contained remains on the filter, except baryta and strontia if they be present in the mineral, but as these oxyds are of rare occurrence in silicates, no allusion will be had to them here.

55. To the filtrate add carbonate of ammonia and boil for some time, when all the lime will be precipitated as carbonate, add a few drops of a solution of carbonate of ammonia to the hot solution to be sure that all the lime is precipitated, should this be the case, filter—the filtrate will contain the chlorids of the alkalies and chlorid of ammonium; it is evaporated to dryness over a water-bath in a small platinum capsule; the capsule is carefully heated to expel the sal-ammoniac, and finally warmed up to 7 or 800° F., it is then weighted with its contents, and the chlorids if mixed, separated in the way mentioned (45 and 46). The amount of sal-ammoniac to be expelled is quite small, not equalling the weight of mineral originally employed.

56. Nothing in analysis can be simpler or more speedy than this process. Its constant accuracy still lacked some little to render it perfect, as usually an amount of alkali remains behind, represented by from $\frac{2}{10}$ to one per cent. of the mineral used, certainly a small amount, but still too much to be omitted in an accurate analysis. This also must be arrived at, and it can be accomplished in the following manner.

57. After the fused mass has been treated with water filtered and washed as in (54), the filter and its contents are dried, the latter are detached from the filter, and rubbed up in a glazed mortar with an amount of sal-ammoniac equal to one-half the weight of the mineral, and reheated in a platinum crucible exactly as in the first instance, treated with water, thrown on a filter and washed, the filtrate added to that from the first fusion, the whole treated with carbonate of ammonia, and completed as in (55).

58. This second fusion complicates the method but little, as the residue on the filter readily dries in a water-bath into a powder that is easily detached from the filter, and the small portion adhering to the latter may be disregarded, as the alkalies remaining rarely exceed more than $\frac{1}{500}$ of the whole mass, and in most instances not more than $\frac{1}{1000}$. In many analyses made, one fusion sufficed for the entire extraction of the alkalies, but as a few tenths would occasionally remain behind, we preferred the additional fusion to get at that small quantity, and to entitle it to rank as a method by which all but the merest trace of the alkalies could be extracted from the insoluble silicates.

59. The proportion of sal-ammoniac added to the carbonate of lime as here recommended, is arrived at after numerous experiments. By increasing the sal-ammoniac, and thereby augmenting the amount of chlorid of calcium formed, the mass fuses more thoroughly, but the water does not disintegate it as completely as when the ammoniacal salt is less; also the accumulation of this latter at the end of the process is less, an object not to be disregarded. The advantage of thus estimating the alkalies in insoluble silicates is obvious;—the long routine of separating silica, alumina, lime, &c., is done away with—the accumulation of chlorid of ammonium is very trifling,—and lastly, the alkalies are obtained directly in the form of chlorids. The method will vie in accuracy with any other, including the one already mentioned in the first part of this paper, and at the same time it is unequalled in simplicity, speed of execution, and constancy of results.

60. In examining for alkalies qualitatively, one fusion will of course be all that is necessary, and the action of the water need not be continued more than thirty minutes before filtering. This method will not answer when boracic acid is present in the silicate; the manner of proceeding in such a case will be mentioned in a future paper on the determination of Boracic acid in minerals.

61. There is nothing new in the attempt to dissolve out the alkalies by water, from a silicate that had been heated with lime. M. Fuchs used the method for procuring lithia from lepidolite, but of course his efforts were entirely directed to procuring the lithia from the mineral, and not to estimating its quantity, as the method he followed could not have furnished such results. I have also lately learned that Mr. A. A. Hayes of Boston, proposed and employed a mixture of chlorid of calcium and caustic lime, to decompose alkaline silicates, heating over a lamp and subsequently treating the mass with water to extract the alkalies or chlorids; as little has been heard of this process, I presume the author found it defective. If we are correctly informed, the proportions used were three parts of chlorid of calcium and one of caustic lime, experience proves, that however readily such a mixture may reduce the feldspars, it fails when tried on kyanite, zircon, micas and other silicates difficult of decomposition. This

arises from the fact that the chlorid of calcium has but little decomposing effect on the silicates, its action being simply that of a menstruum in which the lime can act conveniently on the mineral.

62. The use of lime or its carbonate mixed with chlorid of calcium or chlorid of ammonium, for the purpose of effecting the decompositions alluded to, would be considered by me of questionable utility if the mixture were not so proportioned, and employed as to decompose the most difficult silicates if necessary; for unless this be done, we can at no time be certain that the decomposition is complete. As a general rule for decomposing silicates by lime or soda, it is far better to use a charcoal fire than the flame of a lamp, as it is better to heat too high than not to heat sufficiently the mineral to be acted on.

Complete analysis of an insoluble silicate on one portion of the Mineral.

63. The effort to accomplish an analysis of this description deserves no encouragement, from the almost invariable inaccuracy attending the results. If we have a given quantity of any one of the silicates alluded to, requiring analysis, we had better subdivide it, however small the entire quantity may be, ascertain one set of ingredients by the soda, and the other by the lime fusion; for the results thus obtained, may be relied on as more accurate than those furnished by an analysis of the whole quantity, through the agency of baryta or hydrofluoric acid.

64. Should it be desired to undertake the analysis on a single portion, I would recommend the silicate to be attacked with *carbonate of baryta mixed with the chlorid*—three to four parts of carbonate and two of chlorid: this mixture can be made to decompose all silicates at a much lower temperature, than when the carbonate alone is used, but its action is not near so powerful as the carbonate of lime and sal-ammoniac.

65. This terminates an account of my labors in the determination of the alkalies in insoluble silicates, the conclusions have been arrived at from more than two years experience, and over a hundred alkali determinations by myself and others, made on minerals of the most varied composition. In my laboratory, an accurate alkali determination is one of the most simple and speedy analytical processes now conducted, and the presence of magnesia in no degree complicates the result. A little experience will no doubt bring others to the same conclusions. Many singular decompositions of salts have been noticed in the course of these researches, but as they do not bear directly on the object of this article, they will be made known on another occasion.

Many analytical processes mentioned in this article can be applied when operating on soluble silicates.

Laboratory of the University of Virginia, May 10th, 1853.

Art. VII.—*On a method of constructing an Observatory on a Dwelling-house ;** by Mr. John Campbell.

The idea of placing a telescope sufficiently large to require a revolving dome upon the top of a dwelling-house is so novel, that those who are interested in such subjects will doubtless wonder how a dome could be constructed in a situation of the kind, when as in this case, such an addition was not contemplated at the time the house was erected. An account of the manner in which the thing has been accomplished, may therefore be acceptable to some persons, and perhaps be the means of inducing others imbued with a love of the sublimest of the physical sciences, to make a similar experiment.

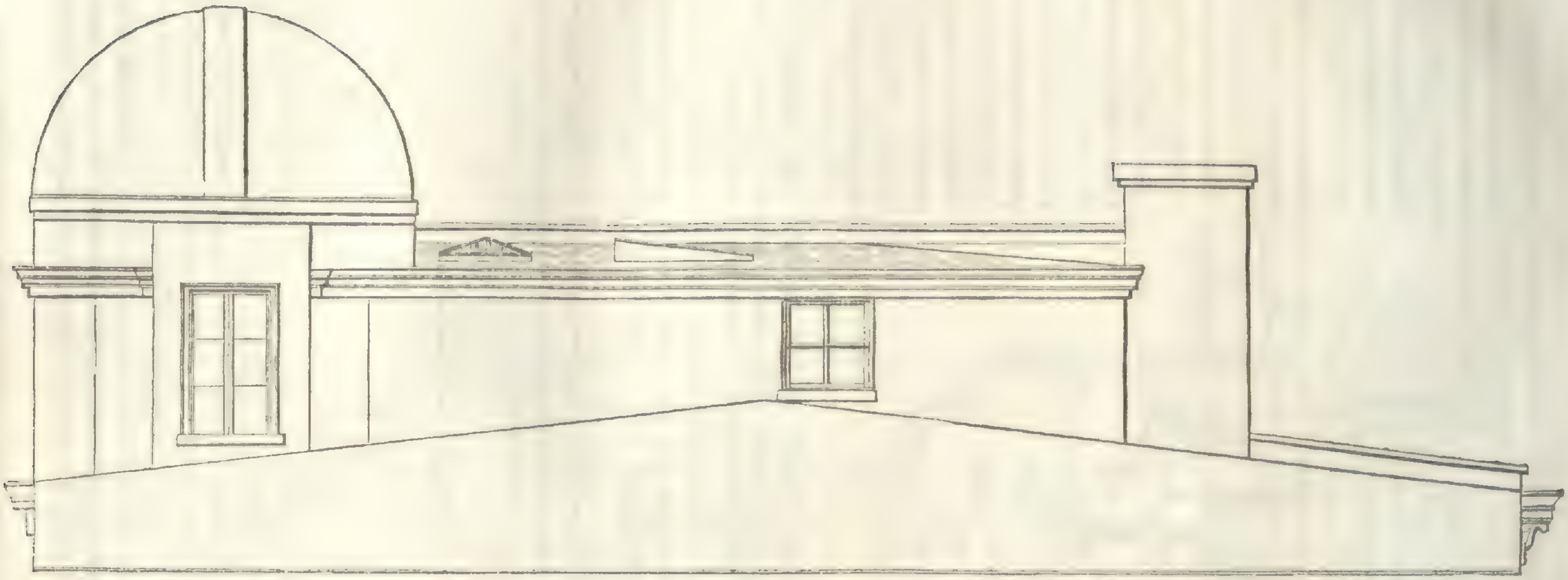
The house is situated in 16th Street, near the 5th Avenue. It is thirty feet wide, eighty feet deep, and four stories high. Like most modern houses it is constructed with an under cellar, the foundation walls are therefore about fifteen feet below the level of the street.

The hall is ten feet wide, and the partition wall which separates this part of the house from the rooms, is of brick, and extends to the roof. This, and the adjoining gable wall were raised, so as to make another story over that part of the house, and a room was thus obtained ten feet wide, and thirty-five feet long. Twelve feet at one end is appropriated for the dome and telescope. Fig. 1. The remainder makes a convenient appendage for books, apparatus and reading. The Observatory or equatorial room, is furred off, so as to make an octagon of twelve feet span, to effect which, it was necessary to project a little over the partition wall, on the roof of the main building, which will be easily understood by reference to the plan, fig. 2. See p. 64.

The octagonal shape is preserved to the height of five feet, it then assumes that of a circle to correspond with and support the wooden curb, which constitutes the bed plate of the dome, and upon which that superstructure is made to revolve, at the height of seventy-feet from the ground. Three stout beams rest upon the walls across the centre of the octagon, making a base or support for the pedestal of the telescope. The floor is raised three feet above that of the reading-room, care being taken not to permit any thing to rest upon, or touch the three beams which sustain the pedestal.

A door opens into the reading-room, and another upon a platform, over the roof of the other part of the house. Opposite to these doors are windows for light and air. See ground plan, fig. 2.

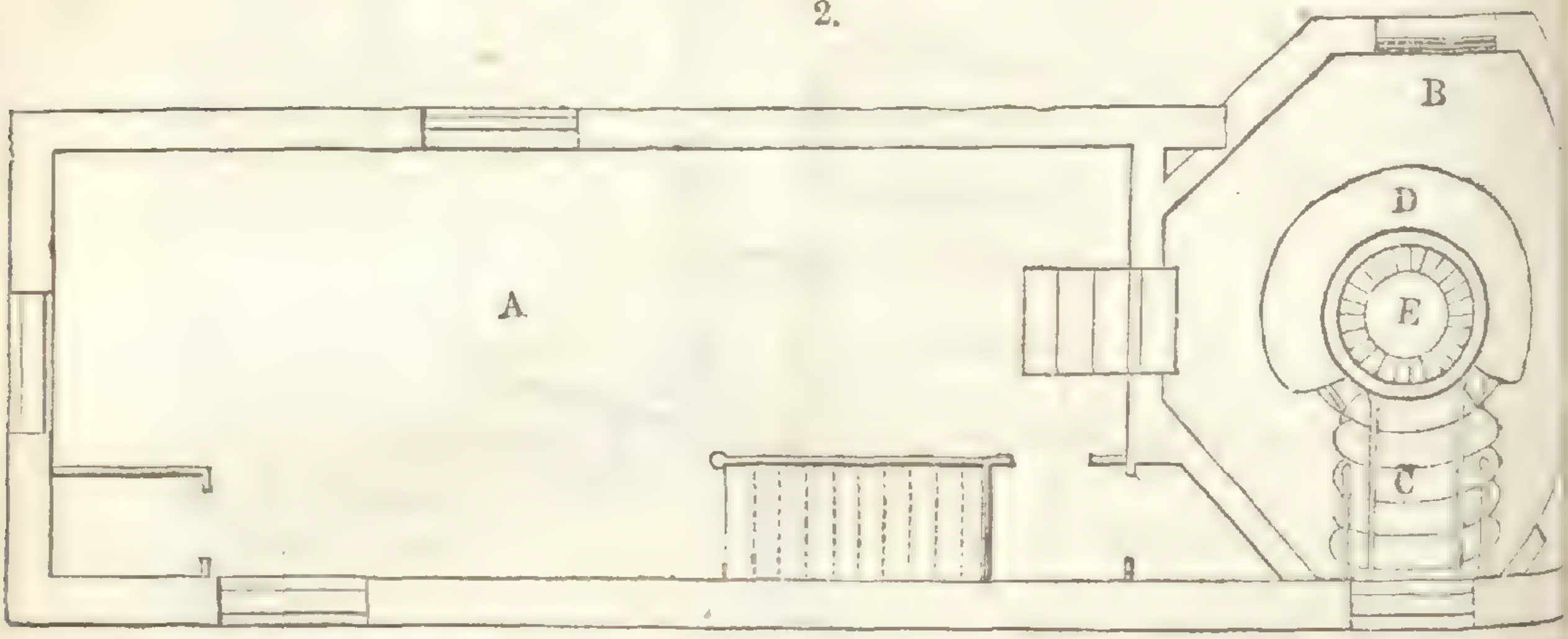
* The above description by Mr. Campbell of a convenient method of adding an astronomical observatory to a dwelling-house in a city, is deserving of attention from amateurs in the science. The author states in a letter to the Editors, that he will send a copy of his paper on the subject to any one who may be interested, and shall be happy to see them in New York and give any further information.—Eds.



Appearance of the Dome from the outside.

It is hardly necessary to say that the foregoing arrangements are altogether local, and on any other site would be varied according to circumstances.

2.



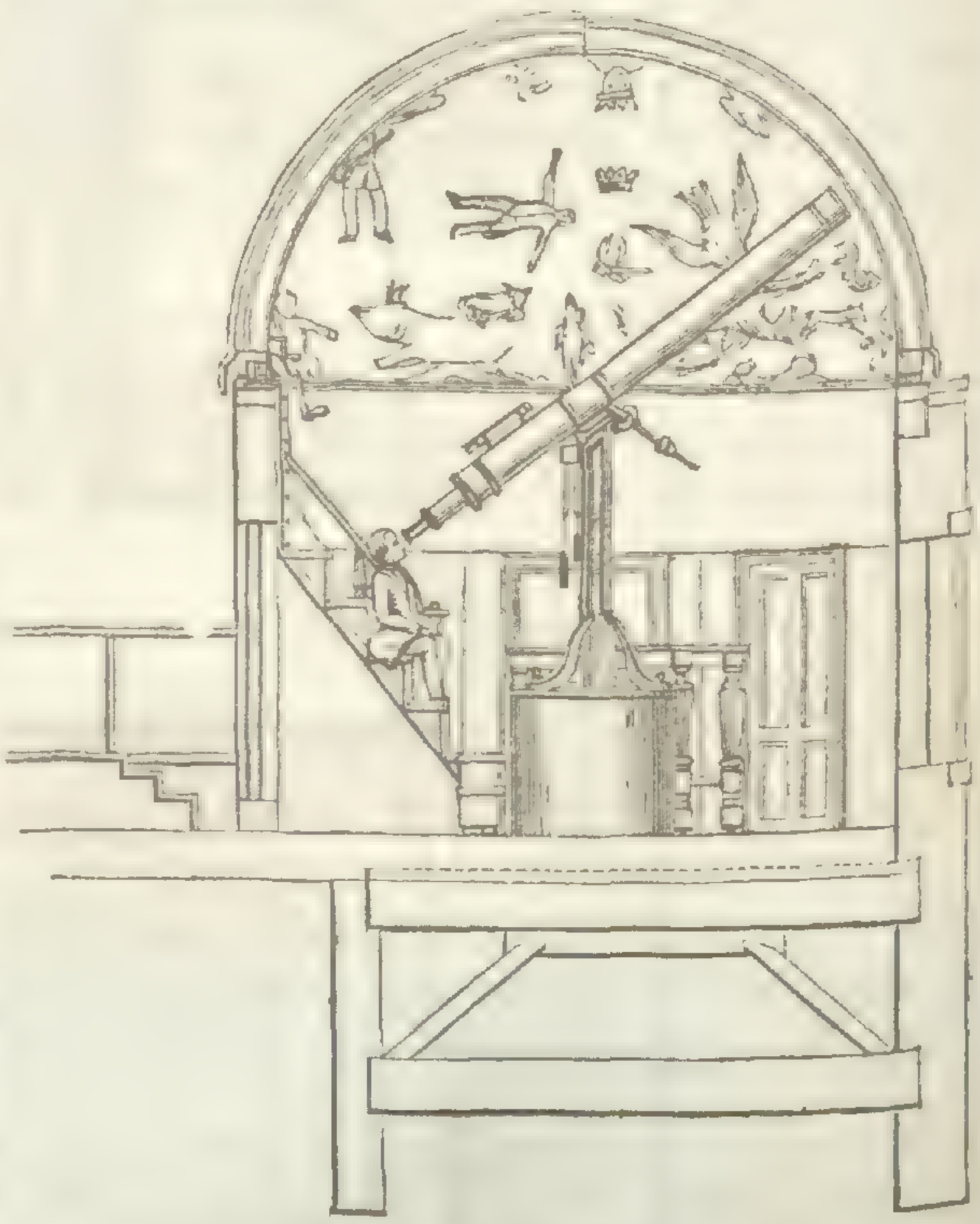
A, Reading room.—B, Observatory.—C, Observer's seat.—D, Reading table.—E, Pier of the telesco

Upon the bed plate before mentioned, is placed a circular rail, twelve feet in diameter inside, three inches wide and one inch thick,—upon the upper surface is a raised bead or bearing. B, figure 4, is a sectional diagram. This rail was cast at the West Point Foundry, in one piece, and turned in a lathe, so that the bearing should not only be a true circle, but also smooth and level.

The dome is twelve feet in diameter, inside, the base being a counterpart of the curb, which constitutes the bed plate. It is built in the usual manner with ribs, sawed to the proper circle, of well seasoned pine, that it might be light, and with great care, that it might be an exact hemisphere.

Two stout ribs cross the dome, equidistant from the centre and fifteen inches apart, forming the aperture for the telescope; they are five inches wide and three inches thick, and are braced together on one

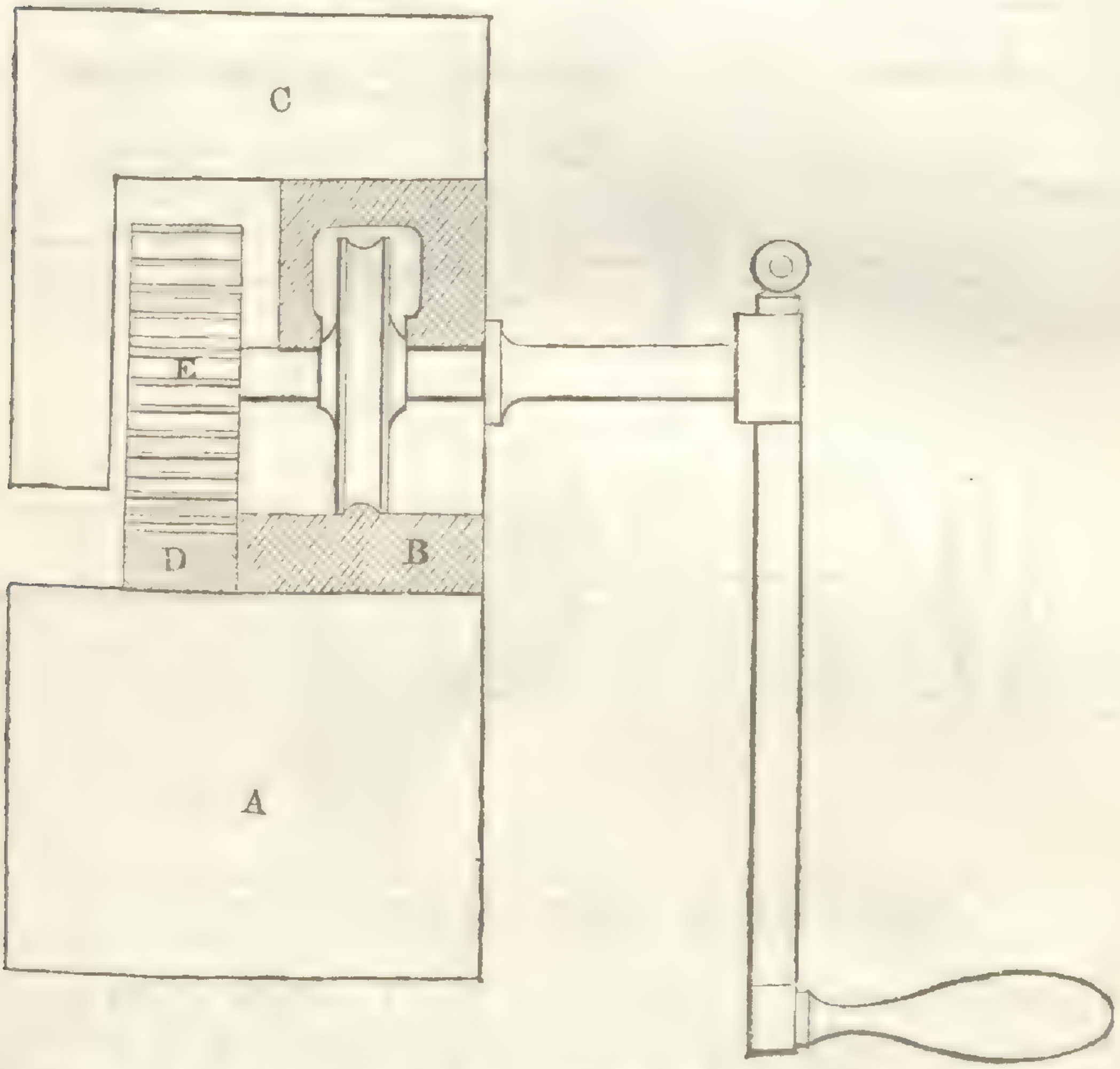
3.



Sectional view of the interior of the Observatory.

side, with four iron bands at equal distances, to strengthen the structure, and keep the ribs in their proper positions, as they are what may be termed the *railroad* of the door which closes the aperture. The dome is covered with tin, except the space between the two main ribs; on one side this space is covered with zinc, lapped sufficiently to exclude rain, and secured with screws, that it may be easily removed in case of any derangement of the chain or guide pullies, which this zinc covering overlies.

4.



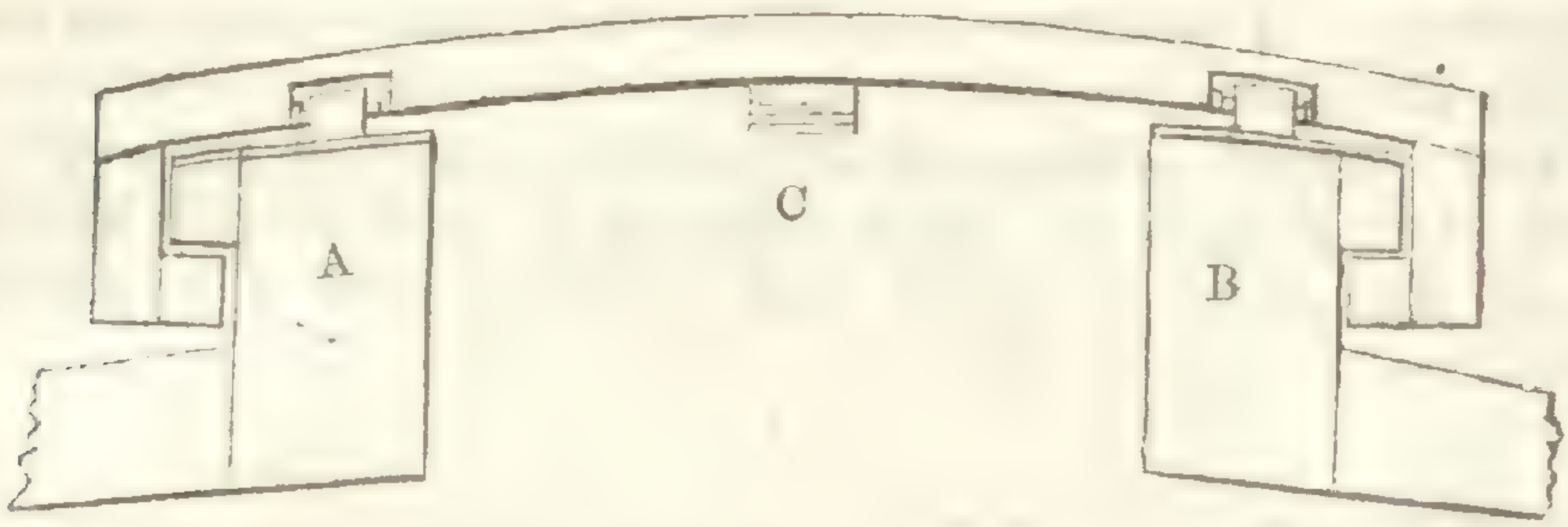
A, Wooden curb or bed plate.—B, Circular rail.—C, Base of the dome.—D, Rack encircling the rail.—E, The pinion.

The aperture extends a little beyond the zenith. It is closed with a sliding door, made to a circle exactly corresponding with the outer surface of the main ribs. The door is secured in the usual way, to exclude rain, and at the same time allow freedom of motion, that it may slip over the zenith to the opposite side. It is covered with tin, and made as light as possible, consistently with the requisite strength. See fig. 5.

The handle, for moving it, is at the horizon, just above the observer's seat, the power being conveyed to a pinion under the upper extremity of the door, near the zenith, by means of a chain passing up the side of one of the main ribs, over guide pullies.

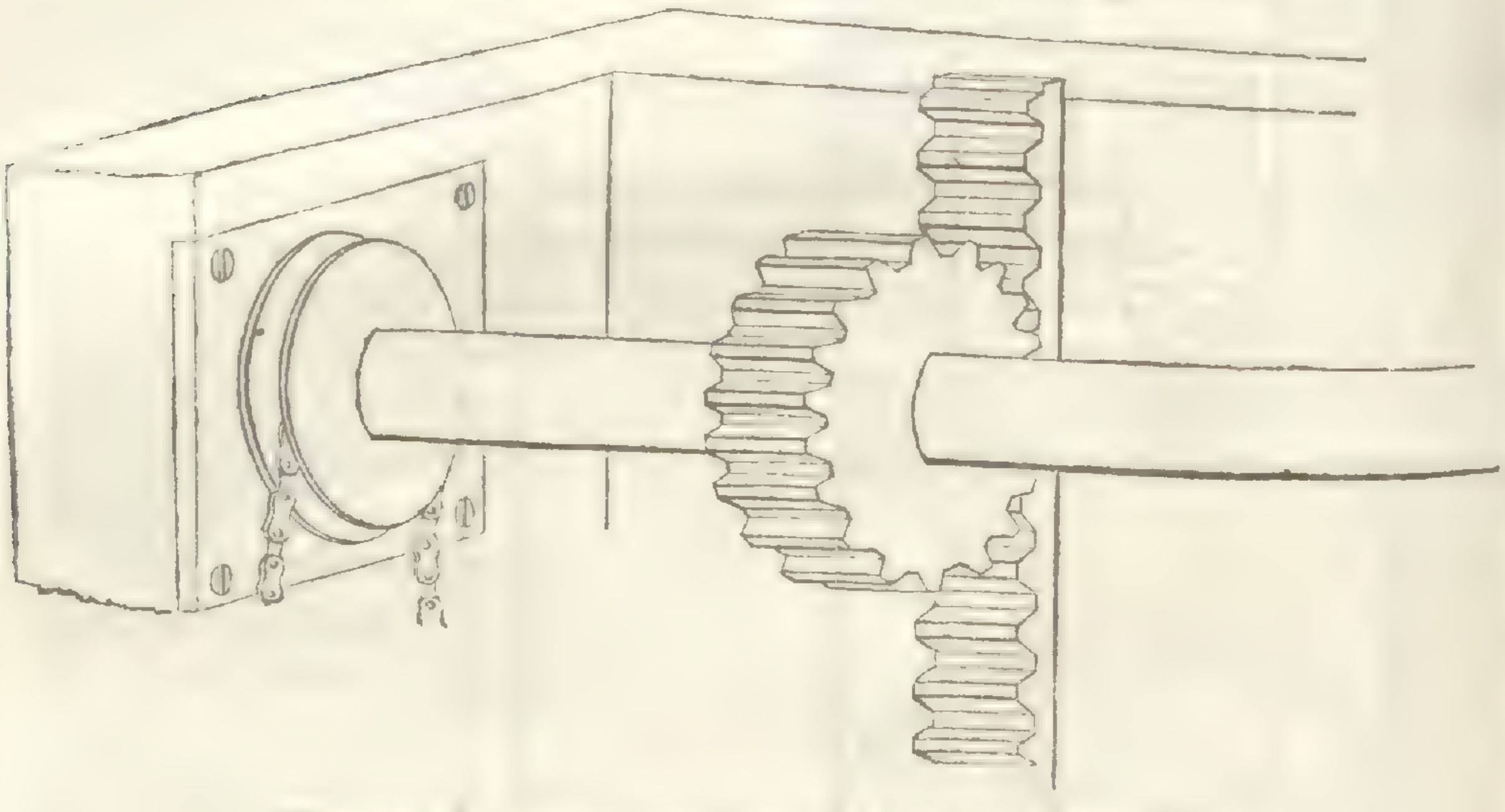
On the under side of the door is a rack, to fit the pinion. Figs. 5 and 6.

5.



A, B, The two main ribs.—C, Rack screwed to the under side of the door.

6.



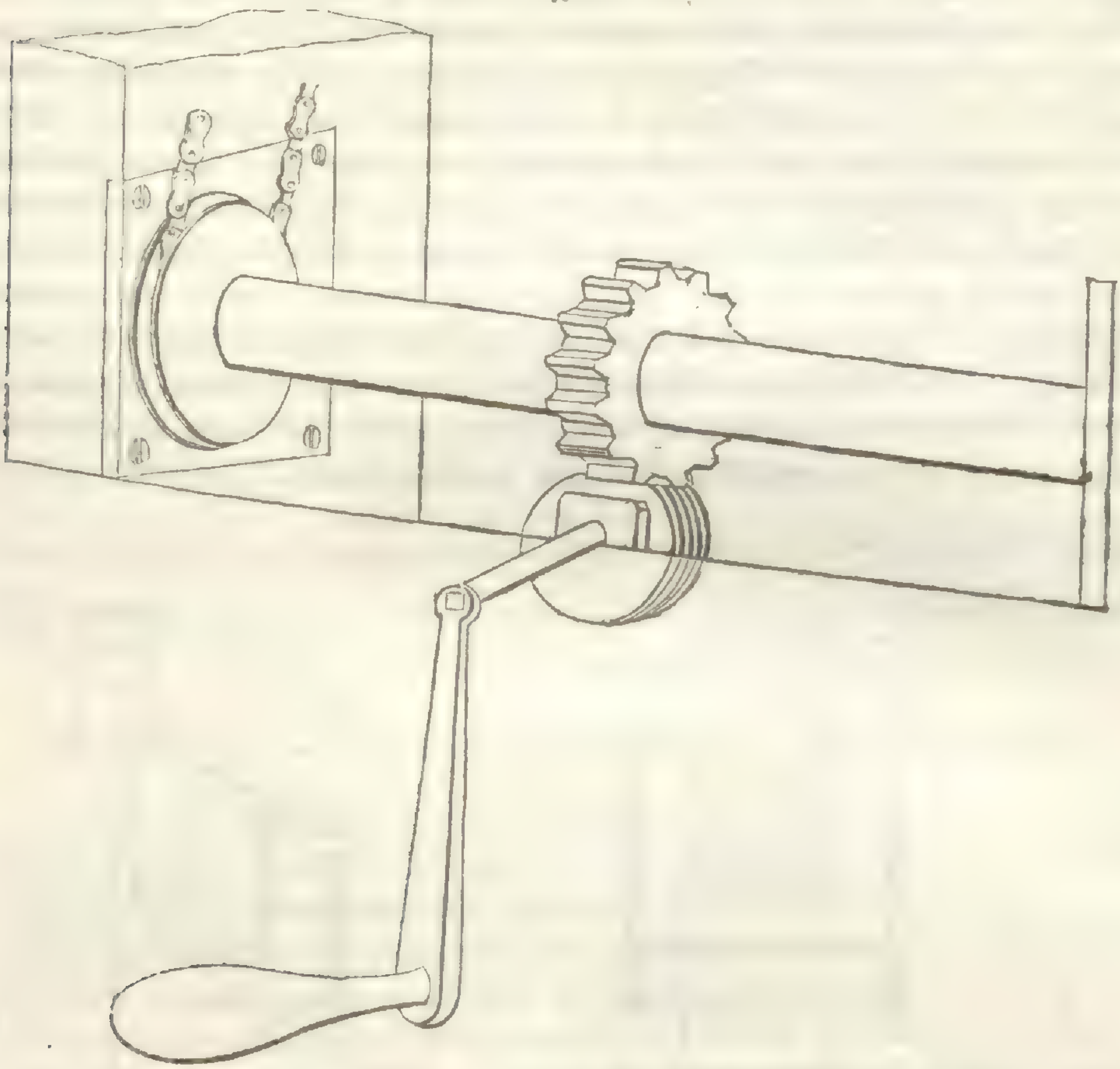
Pinion at the upper extremity of the door near the zenith.

An endless screw is introduced, fig. 7, which gives rather a slow motion, but has the merit of great ease, and of sustaining the door at any desired elevation. In order that the aperture may extend a little beyond the zenith, one foot of the door is disconnected and remains at the horizon, but may be elevated when necessary.

The machinery for turning the dome is very simple. It revolves upon seven small wheels of four inches diameter and one inch thick—in which grooves are turned to correspond with the bead on the iron rail. These wheels are fitted into cast iron boxes, and the boxes bedded equidistant in the base before mentioned. The shaft of one of these wheels is made long enough to receive a pinion at one end, and a handle at the other. The pinion fits a rack which encircles the rail, and is concealed from view. Fig. 4.

The handle and also the operator move round with the dome, which is accomplished in a very convenient manner, by the peculiar construction of the observer's seat. This is a small flight of

7.



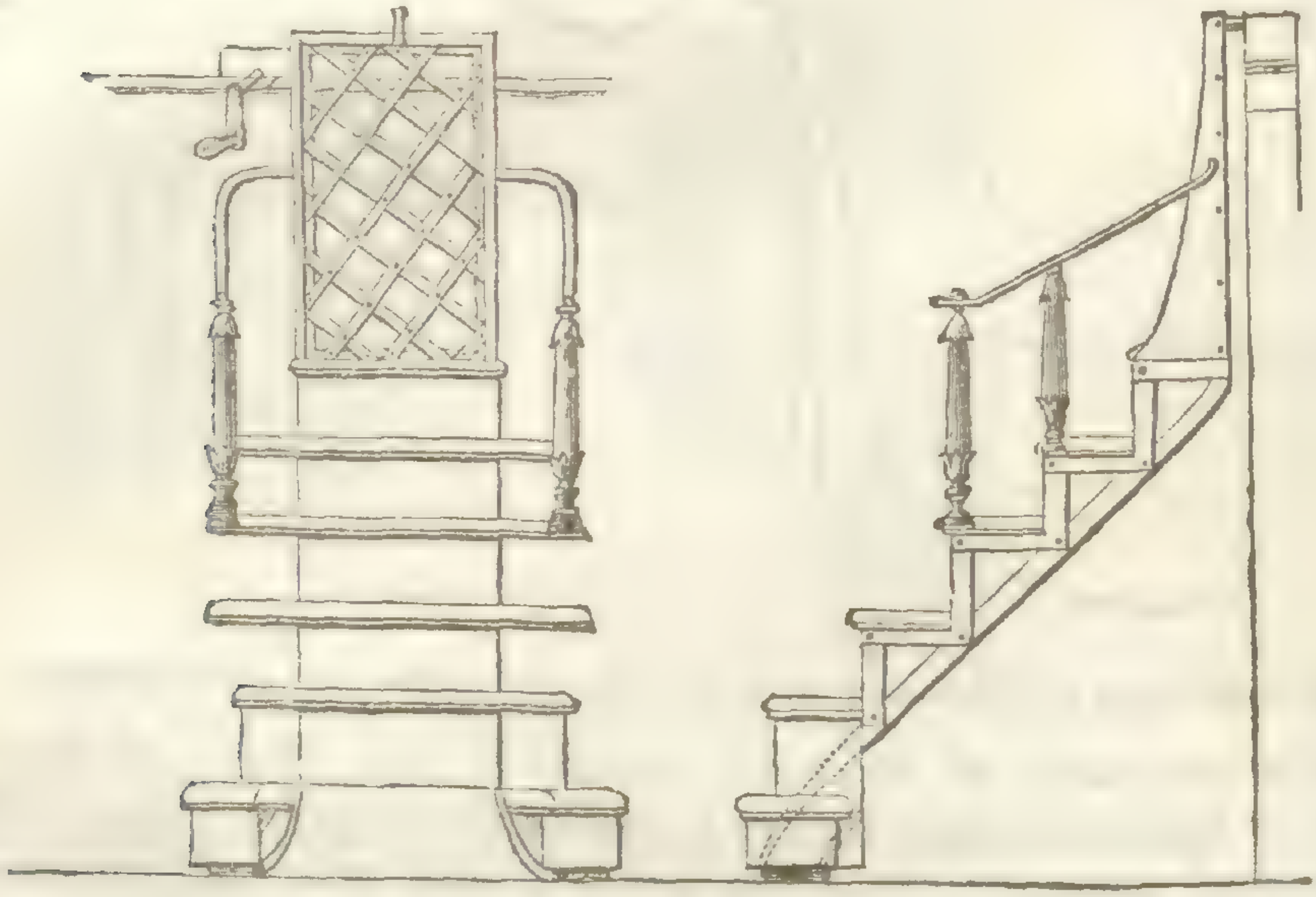
Endless screw and pinion on the horizon for moving the door of the aperture.

stairs, at an angle of elevation, suited to the sweep of the eye-piece, so that each step makes a convenient seat. Fig. 8. The frame is of wrought iron—the string pieces reach to the base of the dome, to which they are secured, as seen in the plans. The bottom of the stairs rests upon two wheels, in which grooves are made to suit a circular rail of half round iron, which is secured to the floor.

The handles for raising the door of the aperture and for revolving the dome, are near to each other, and can be easily turned by the observer. A circular platform or table is substituted for the ordinary reading steps. It is supported upon legs (with rollers) sufficiently long to give the observer command of the circles and equatorial machinery. The table is secured at both ends, to the bottom steps of the observer's seat, and consequently revolves with it, see figs. 2 and 3. It will be perceived that by this arrangement the aperture, the observer's seat, and the reading table are so constructed that the moving of one necessarily involves the

moving of all, and therefore they always retain their relative and proper positions. The pedestal or pier is simply a drum of boiler iron, three feet in diameter, and the same in height. It stands upon the three beams before mentioned, is lined with brick, like a well, and covered with a smooth round flag stone, projecting an inch over the iron. The mahogany frame of the telescope, having four feet, with adjusting screws, stands upon the stone. The steadiness of the pier is remarkable, and may be accounted for by the fact that the rock in the vicinity lies near the surface, and in many cases has been excavated to a considerable depth, to form the under cellars of the neighboring houses, which in a great measure serves to insulate the walls which support the telescope. A map of the Northern Hemisphere, with the figures, is painted upon the concave surface of the dome, and the stars to the fifth magnitude are represented in their proper places.

8.



Front and side view of the observer's seat.

The telescope is an achromatic refractor of eight inches aperture, 10 feet 6 inches focal length, made by Mr. Henry Fitz, of New York. It is furnished with six eye-pieces, of the Huygenian form, magnifying from 60 to 480 times, and has a finder of two inches aperture, and twenty-four inches focal length.

The stand is after the Frauenhofer plan, or the equatorial or parallactic style, but is made entirely of cast iron, excepting the circles, which are of brass. The axes are both cast hollow. The declination box and polar axis, being in one piece, as are also the saddle for the tube, and the declination axis.

It will be readily perceived that some method of securing the true position of the declination axes is required, and this is effec-

ted by means of an excentric bearing for the end of the axis, to which the circle is attached, and which is readily turned, within the declination box, until the adjustment is found to be correct, and then secured. A clock is attached to the telescope for keeping the object in the field of view, and an important improvement has been made in the manner of communicating the motion to the hour circle. The thread to fit the tangent screw, is cut in the edge of a ring, detached from the hour circle, and merely pressed against it on a conical bearing, by the elasticity of a thin brass plate, which is secured by four screws, that give the requisite friction.

This detached arrangement permits the telescope to be moved in any direction, while in connection with the clock, and obviates the necessity of clamping and unclamping, thereby greatly diminishing the danger of injury to the instrument.

Art. VIII.—*On the Phosphorescence of some Marine Invertebrata;* by M. A. De Quatrefages.

Second Part.—*General observations on Phosphorescence.*

1. *Description of the phenomenon.*—It would be useless to repeat here all the details given by travellers; I will confine myself to some remarks on my own observations.

The phosphorescence of the sea has appeared to me under two different forms: 1st, a result of scintillations more or less numerous, always isolated, and not giving at all the idea of a liquid in itself luminous: 2nd, a general glow more or less uniform, the phosphorescent substance seeming to be dissolved in the water itself.

In both cases, phosphorescence is equally a result from living animals, directly emitting the light, but the species which produce the phenomenon are different.

A. I have often observed the first mode of phosphorescence on the western coasts of France, at points peculiarly exposed to the action of currents and waves. At Chausey, especially in the small channel called "le Sund de Chausey," I have seen very numerous and brilliant sparks brought out by each stroke of the oar. The track of the vessel seemed for a moment as if strewn with diamonds, but these sparks, always very brilliant, and appearing at the same instant, never communicated a general glow to the water. They remained completely isolated, and were distinct from the dark surface of the sea. At Brehat, St. Malo, and St. Vaast, I observed similar facts. The fishermen whom I questioned, all assured me that in these regions, the sea never presented a different appearance; the young men who had never left their native

coasts, did not seem to understand my inquiries relative to a more general or diffused phosphorescence. M. Beautemps-Beaupré, mentions his observing phosphorescence of this kind during one of the numerous excursions in which he was engaged, while making his magnificent atlas of the coasts of France. But he cannot recall the exact locality. It was in the neighborhood of St. Brieuc, and it may be that this single observation was made in some well sheltered harbor, like the port of Paimpol.

If the sea itself rarely presents any remarkable phosphorescence in the localities of which I am about to speak, it is not so with the marine plants which are left by the tide. In some circumstances, I have seen masses of the Fucus kindle up when seized a little rudely; but even then the light was in isolated points, which the eye easily distinguished from one another. In no case did the stalks or the leaves present the uniform tint of a metal at a white heat, and the water which ran out freely was never luminous. Moreover, the part of the beach which the sea had just left dry, remained perfectly dark. At most, only a few sparks might be seen over a space of some extent.

Water drawn from the sea in the circumstances of which I speak, and when the scintillations were most numerous and most brilliant, often became suddenly obscure, or presented only some few luminous points, when the vase containing it was violently shaken, and these ordinarily disappeared instantly. This same water poured out from some height, presented nothing peculiar. Never, in the regions of which I speak, have I seen the waves breaking on a shore presenting the appearance described by travellers.

B. The second kind of phosphorescence I saw for the first time near Stromboli. Here the effects of the light were heightened by the dark hue of the waves around the volcanic cone; moreover, at Boulogne, and probably at Havre, Dieppe, Ostend, &c., this phenomenon is as complete and interesting as at Stromboli.

At Boulogne, the phosphorescence is apparent throughout the harbor, except where the waters of the Liane flow into it. It is diminished and perhaps destroyed towards the entrance, between the two dykes. It is very decided through the whole port properly so called, in the basin, and especially in the little cove named the "Parc aux huitres." The last locality being very accessible, afforded opportunity for studying all the details of the phenomenon.

However favorable the circumstances for observation, the water when quiet was always perfectly dark; but the least movement drew forth light. A grain of sand cast upon the dark surface produced a luminous spot, and the undulations of the water were so many bright circles. A stone as large as the fist, produced the same results in a more intense degree, and moreover each

splashing occasioned a scintillation like that of a bar of iron at a white heat when struck upon an anvil. The entrance of a steamboat when the phenomenon was most apparent, was a magnificent sight, and recalled to mind the descriptions of travellers.

The "Parc aux huitres" was always bordered by a phosphorescent girdle, resulting from the incessant undulations of the sea, which reached the shore under the form of small waves; but in perfectly fair weather this light was too feeble to be distinguished at a distance. When these undulations were only three to four inches high, the ring might easily be seen from the pier, throughout its whole extent, and was especially marked in the inner part of this little harbor.

At Boulogne, as at Stromboli, these luminous waves seen from a distance, presented a uniform tint of a pale dull white. It might be called almost a froth, resulting from the action of the waves against the shore; and seen at mid-day under the most favorable circumstances, that was all I could distinguish at a distance of 70 to 80 yards. In proportion as you advance the appearance changes; the waves as they near the shore, seem crowned with a light bluish flame, which M. Becquerel has justly compared to that of a bowl of punch. When they strike, this brightness becomes whiter and more vivid. On reaching the bank, you often see these same waves under the aspect of surges of melted lead or silver, strewn with an infinite number of bright scintillations, either brilliant white, or of a greenish tinge. The spectacle is then most beautiful, and after having witnessed it on a small scale, I understood the impression left on the minds of travellers who have seen it under the tropics, in all its magnificence. The following are the facts which I have myself witnessed.

The waves in breaking on the nearly horizontal beach of the cove, although so little elevated, covered quite an extent, and the whole space presented a uniform and glowing tint, from which started out innumerable scintillations yet more brilliant, and of a bluish or greenish hue.

As the water became absorbed by the sand, a line more strongly luminous indicated its limit. This effect was especially marked in the little cavities which the shore presented, where the line formed concentric curves which diminished as these little basins were exhausted. On passing a long stick rapidly in the water, it presented in its whole length, the appearance of a blade of silver.

The water taken up at random and poured out from a little height had exactly the appearance of melted silver, and it was the same in the slightest spray. It left upon the hands or clothes bright spots that were quite persistent. At one time, when on a short excursion with M. Bouchard a dog ran barking at us, we threw at him the contents of a small cup, and he fled in terror from what he seemed to take for fire, and troubled us no longer

save at a distance. If we plunged our hands into the sea, when drawn out they were luminous all over, but after a few seconds, they were marked only here and there with bright spots, whose brilliancy remained constant and without scintillations.

The bank recently left by the tide did not however show any trace of phosphorescence; yet at the least shock, it became luminous, and seemed literally to glow under the steps of the observer. In some circumstances, wherever the foot rested on the sand or gravel, it seemed like burning coals beneath the tread, and this appearance was equally perfect, with more or less brilliancy, even to a distance of some inches.

The Talitri, so numerous on our sandy shores, and whose habits have gained for them from the fishers, the name of sand-flea, become luminous by contact with the phosphorescent water,—a fact to be noted; for at first one might be led to imagine that they were the cause of the light. Nothing can be more curious than to see these sand-fleas leaping by hundreds, and appearing like the scattering of tiny sparks.

2. *The Animals that produce the phosphorescence in the two preceding cases.—a.* At Chausey, Brehat, St. Malo, Saint Vaast, I have many times sought for the cause of the bright sparks, which I saw shining and then vanishing in darkness. In each case I met with living animals, and these animals were always Crustacea, Ophiura or Annelida. I usually found the first in the water drawn up either from channels or at some distance from the shore. The second were under stones, or in the masses of seaweed. It was especially to the Annelida that the Fucus owed its brilliancy.

These results explained all the circumstances of the first kind of phosphorescence. The Crustacea, whose movements are energetic and whose locomotion is extended, cannot easily be collected in sufficient quantity on a given point to have their scintillations appear like a uniform tint. Besides there is nothing in the habits of the species I have examined, to lead one to suppose that they are inclined to collect in numerous bands. The size of the Ophiura prevents such an idea with regard to them; and the smaller Annelid for a like reason cannot contribute to such a result. Thus the light produced by these different animals is always seen in points more or less near each other, but never really blended.

b. At Boulogne, on the contrary, we find this brilliant light exclusively due to Noctilucæ. With the most careful examination, I have never found in my vases a single Annelid, or a single phosphorescent Crustacean.

Many circumstances, some of which will be explained beyond, illustrate the particular mode of phosphorescence of the sea, rendered luminous by the presence of these Rhizopodes. We will

first notice their size and great number. The diameter of these Noctilucæ, varies from about $\frac{1}{5}$th to $\frac{1}{3}$th of a millimeter; but their abundance more than compensates for their minuteness, each drop of water, as observed by Suriray and M. Verhaeghe, containing one or more. The following calculations will give some idea of their vast numbers.

In taking up some water at random from a brilliant wave, I filled a tube about a decimeter in height. After being left a little time quiet, the deposition of Noctilucæ on the surface of the liquid was about $1\frac{1}{2}$ centimeters in thickness. Thus the Noctilucæ composed about $\frac{1}{7}$th of the phosphorescent water. Again I took the water from the surface and filled a vessel about one-half. The whole height of the liquid was about 15 centimeters, and that of the mass of Noctilucæ was about five centimeters; here the proportion was about $\frac{1}{3}$. Finally, I remember that at False Bay, M. de Tessan found the proportion equal to $\frac{1}{2}$. From these numbers, it is easy to understand how the sea, rendered luminous by the Noctilucæ, may present a uniform brilliancy, irresistibly impressing the idea of a phosphorescent solution. When the surface of the sea is tranquil, as in a well protected harbor, the Noctilucæ, because of their small specific gravity, form a continuous bed, and the least movement is sufficient to cover that dark surface with a brilliant mantle. When the movement of a vessel at once breaks in upon this mass of Noctilucæ, and also calls out their simultaneous phosphorescence, the myriads of bright points lying in the trough of the wave, present one universal hue. From a distance, the eye sees throughout a uniform brilliancy, and near by distinguishes only the most brilliant scintillations or those thrown out by the animals at the immediate surface of the water. These brilliant waves are like so many nebulæ resolved by the eye only in part.

PART THIRD.—*Observations and Experiments on the Light of the Noctilucæ.*

[Instead of giving a full translation of this Part of the memoir as has been done of the preceding, we offer here an abstract presenting in brief the conclusions of the author.—EDS.]

1. *In a sea rendered phosphorescent by Noctilucæ, the light proceeds only from the body of these animals.*—This proposition is proved by direct microscopic examination;—and by the water's being deprived of all light when the Noctilucæ are filtered out, and becoming luminous again when they are restored to it. In a tube, of the seawater, the Noctilucæ if left quiet soon form a layer at the top of the liquid, and the light is confined entirely to this layer of the animals.

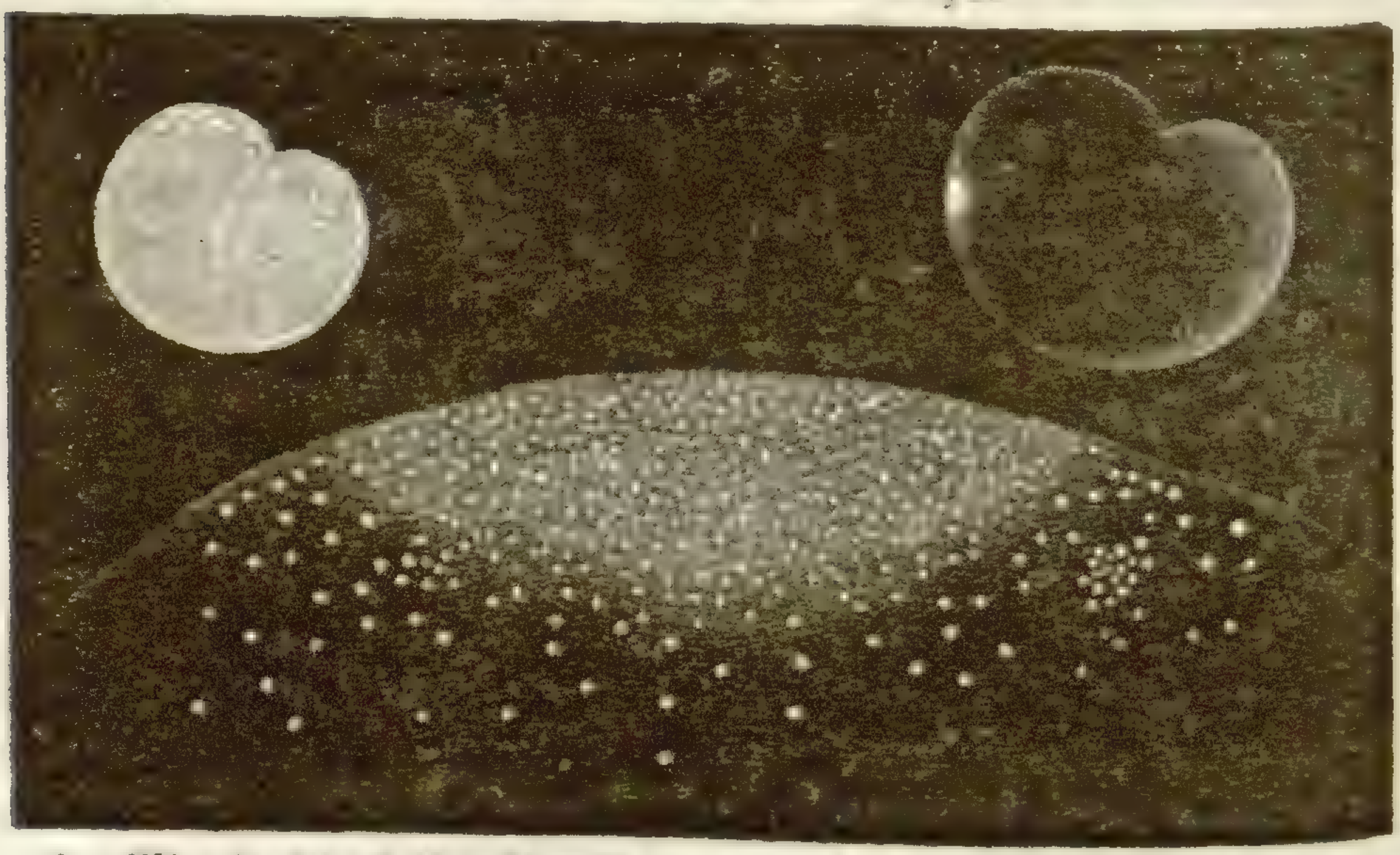
2. *The production of light is independent of contact with the air.*—The flashes of light that are produced with the breaking of every wave might seem to show that the access of the animals

to the external atmosphere was essential to the result. But on the contrary, it is found by observation that in a vase of seawater containing the Noctilucæ, the bed of these animals that collects at the top of the vase is equally luminous in every part.

3. *Color of the light.*—When the Noctilucæ are in full vigor of life in quiet water, the color is a clear blue. But on agitating the water, or in the waves of the sea, the light becomes nearly or quite white or like silver sprinkled with some greenish or bluish spangles.

4. *Intensity of the light.*—M. de Tessan states that in some tropical seas, the phosphorescence is so bright from the breaking waves, that he could read ordinary type at a distance of fifteen paces. The light from the Noctilucæ cannot compare with this. At the head of the cove of the "Parc aux Huîtres" at Boulogne, it was not possible to tell the hour with a watch, when the waves were breaking at the observer's feet. With a tube 15 millimeters in diameter, in which the Noctilucæ formed a bed at the surface nearly 20 mm. thick, the figures of a watch face could be read; but strong agitation of the tube was necessary, and it was requisite to hold it close to the glass of the watch. Four to five teaspoonsfull of Noctilucæ were collected in a filter, and on producing the phosphorescence by this means, the hour could be told at the distance of a foot.

5. *No disengagement of heat sensible to a thermometer accompanies the phosphorescence.*—This fact was established by placing the bulb of a thermometer in the Noctiluca water while it was quiet, and then giving it a shake to produce the phosphorescence. The experiment was varied in different ways.



6. *The light of the Noctilucæ may be produced over the whole surface of its body or only a part of it.*—After a violent agitation, the Noctilucæ retain the phosphorescence for some time, so that it may be studied at leisure. With a lens magnifying 6 to 8 diameters, it is easy to see that while some of the Noctilucæ are phosphorescent throughout, others are but partially so. In the figure given above, one of the animals is light over its whole surface,

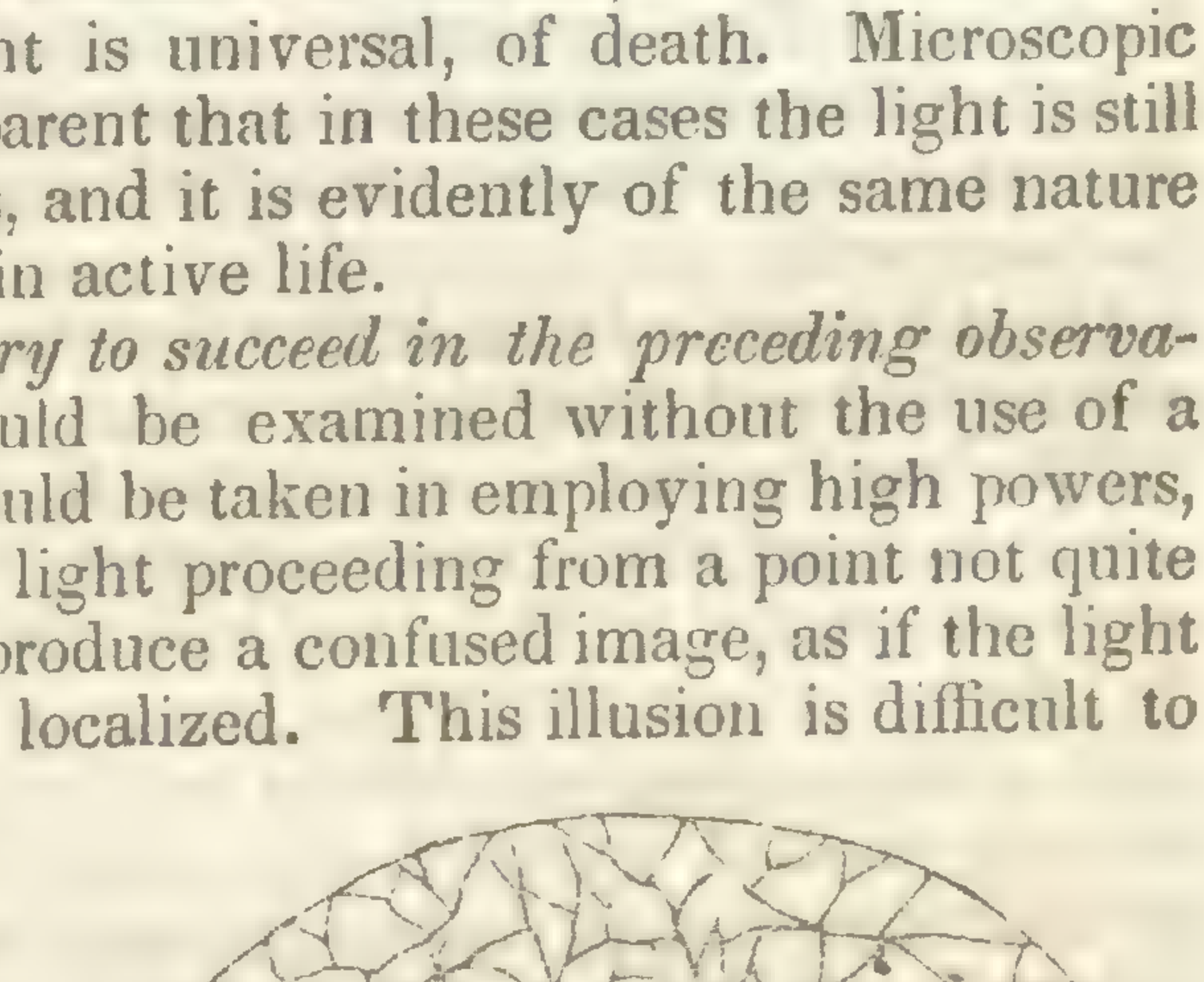
and the other only on opposite sides. With a lens of 10 to 12 diameters, we find that the light often appears successively on different parts of the body. There is hence no circumscribed phosphorescent organ, as in the Lampyri, Elaters, and Pyrosomas.*

7. *The light is due to an infinite number of minute scintillations.*—The preceding figure of a part of a Noctiluca much magnified, represents the actual character of the phosphorescence. There is an immense number of points of light. With a lens of 20 to 30 diameters, the light is like an undefined nebula; but with a lens of 60 diameters, it is partially resolved, and with 150 diameters, wholly, into its constituent spangles. Each luminous spot on the body is found to consist of a cluster of minute instantaneous scintillations, dense at the centre, and more scattered towards the circumference of the spot. Thus the same phenomena take place in the Noctilucæ as were observed by M. de Quatrefages in the Ophiuræ and Annelida. Each spot of light is resolvable into constituent points, and consists of evanescent scintillations.

8. *The light from the dead Noctilucæ or from fragments of them, is identical with that from the vigorous living animal.*—When the light of the Noctilucæ, after frequent excitement, becomes white, it is also more fixed, and finally covers the whole body. From numerous experiments, M. de Quatrefages concludes, that this kind of light is evidence of disease, or of a decline of vigor, and when the light is universal, of death. Microscopic examinations make it apparent that in these cases the light is still made up of minute points, and it is evidently of the same nature with the light given out in active life.

9. *Precautions necessary to succeed in the preceding observations.*—The animals should be examined without the use of a compressor; and care should be taken in employing high powers, not to be deceived by the light proceeding from a point not quite in the focus, whose rays produce a confused image, as if the light were uniform instead of localized. This illusion is difficult to

* The Noctiluca has a depression on one side, and near the middle of this depression is the mouth. At the same place there is a moveable appendage as long as half the diameter of the animal. The body is perfectly transparent. The general envelop consists of two membranes, distinguished with difficulty. The outer is excessively thin and like an epidermis; the inner is thicker, but without a trace of fibres. On compression the envelop acts like a bag full of liquid, and finally bursts. Numerous anastomosing and branching lines radiate from the mouth through the granulous interior.



NOCTILUCA MILIARIS.

avoid with fragments, as they are apt to be folded, so as to bring more than one point of light in the focus at once.

10. *The phosphorescence is not the result of a kind of combustion.*—On taking a barometer tube nearly filled with mercury, putting in some seawater containing Noctilucæ (the water occupied six centimeters of the tube, and the bed of Noctilucæ was three centimeters thick), and then inverting it over mercury, a phosphorescence was produced of the pale white light which indicated approaching death, a consequence of the imperfect vacuum. After one hour and eighteen minutes, the phosphorescence had ceased, and could not be restored by shaking it. Oxygen gas was introduced without effect. It is probable that the phosphorescence, if due to combustion, would have been restored by the oxygen, as happens with the Lampyri, according to Matteucci, under similar circumstances.

Four tubes were filled with water containing the Noctilucæ. Into one, oxygen was poured, into the second, hydrogen, the third, carbonic acid, the fourth, chlorine. The first three gases produced the same effect, and not more than atmospheric air occasions through the agitation its passage causes. After half an hour these tubes were shaken with precisely the same result in all. Chlorine acted like other irritating agents; the light was at first bright and continuous, but rapidly became extinguished. Macaire and Matteucci have shown that the light of the Lampyri is immediately brightened in oxygen, and rapidly extinguished by carbonic acid. The light therefore cannot be alike in origin in the two cases.

11. *All physical agents that produce contractions cause phosphorescence, and in proportion to the intensity of the contractions.*—This conclusion was established by M. de Quatrefages by experiments upon the influence of pressure, heat and electricity; of sulphuric, nitric, muriatic and sulphydric acids; potash, ammonia, alcohol, ether, turpentine, common salt, Owen's liquid, milk, fresh water. With very dilute sulphuric acid, the excitation is strongly marked, attended with a rupture more or less rapid of the filaments uniting the interior mass to the envelop, and finally a detachment of the mass from the envelop, and a withdrawal towards its mouth. A portion of the inner mass and tissues, may cover still the inner surface of the envelop; but after a while they come away from the envelop, and collect about the mouth, leaving the envelop empty. In the dark, there is a very brilliant light at the first contact of the dilute acid with the Noctilucæ; then afterwards there appears a clear fixed white light on one part, which rapidly spreads, till the whole is like a ball of silver. The brilliancy soon after begins to diminish, and rather rapidly disappears. The rupture of the fibres and disorganization of the interior mass, evidently take place consentaneously with the flashes and change in the light.

It is hardly necessary to cite the other experiments in this place. M. de Quatrefages concludes that the light is produced by the contraction of the interior mass of the body; that the scintillations are owing to the rupture and rapid contraction of the filaments of the interior, and that the fixed light which these animals emit before dying, proceeds from the permanent contraction of the contractile tissues adhering to the inner surface of the general envelop. The production of the light is independent of all material secretions. Whether it is accompanied by a discharge of electricity or not, remains to be ascertained.

ART. IX.—*Contributions to Meteorology—Mean Results of Meteorological Observations, made at St. Martin, Isle Jesus, Canada East, (nine miles west of Montreal,) for* 1852; by CHARLES SMALLWOOD, M.D.*

Barometric Pressure.—The readings of the barometer, are all corrected for capillarity, and reduced to 32° F. The means are obtained from three daily observations, taken at 6 A.M. 2 P.M. and 10 P.M.

The mean height of the barometer in January, was 29·607 inches, in February 29·902, in March 29·952, in April 29·470, in May 29·539, in June 29·489, in July 29·555, in August 29·668, in September 29·645, in October 29·689, in November 29·615, and in December, 30·011 inches.—The highest reading was in December, and indicated 30·329 inches, the lowest was in June and was 28·727 inches; the *yearly mean* was 29·686 inches, the *yearly range* was equal to 1·602 inches.—The atmospheric wave of November was marked by its usual fluctuations, the final trough terminated on the 30th day.

Thermometer.—The mean temperature of the air in January, was 12°·65, in February 21°·90, in March 20°·7, in April 38°·38, in May 52°·27, in June 66°·12, in July 72°·33, in August 68°·02, in September 59°·15, in October 45°·69, in November 33°·0, in December 24°·64 F.

The highest reading of the maximum thermometer, was in July, and marked 100°·5; the lowest reading of the minimum thermometer was in January, and was −28°·0. The mean temperature of the quarterly periods, was, winter 16°·45, spring 37°·11, summer 68°·82, autumn 45°·94. The *yearly mean* was 42°·86, and the *yearly range* 128°·5. The greatest intensity of the sun's rays was in July, and indicated 122°·5, the least intensity was in November, and was 62°·4.

The mean humidity of the atmosphere in winter was ·781, in spring ·806, in summer ·810, and in autumn ·895. The *yearly mean* of humidity was ·823.

* The geographical co-ordinates of the place are 45° 32′ N. Lat., and 73° 36′ W. Long.: height above the level of the sea (estimated) 30 feet.

Rain fell on 88 days, amounting to 47·131 inches and was accompanied by thunder and lightning on 17 days.—*Snow* fell on 48 days amounting to 84·61 inches *on the surface.* The equivalent of 1 to 10 as used by the Smithsonian Institute at Washington, for the comparison of melted snow to rain, does not hold good in this climate: it varies from 1 to 5 to 1 to 8. I have undertaken a series of experiments on this point, which I have not at present brought to a close.

The whole amount of snow which fell in the winter 1851–2, amounted to 95·920 inches; the first snow fell on the 25th of October, 1851, and the last on the 16th of April, 1852.

The amount of evaporation was regularly measured and recorded during that period of the year, when the thermometer stood above the freezing point, and owing to frosty nights, and frost also during some days, no accurate measure could be taken. The amount of evaporation in May, was 3·720 inches, in June 3·450, in July 4·150, in August 2·620, in September 2·020, and in October 1·220: this period includes what I consider could be taken with anything approaching to accuracy.

The most prevalent wind during the year was the West, the next in frequency was the E. N. E., the least prevalent wind was the N. by W. The mean of the maximum velocity (as measured by an anemometer similar in construction to Dr. Robinson's) was 17·632 miles per hour; the mean minimum velocity was equal to 0·463 miles per hour.

The Aurora Borealis was visible on thirty-six nights, at the following hours, and its appearance was generally followed by rain in summer and snow in winter.

January 19*th*, 10 P. M. Faint auroral arch—sky clear; 26*th*, 10 P. M. Do., dark clouds in the horizon.

February 15*th*, 4 A. M. Bright aurora in the north, streamers shooting to the zenith; sky clear.—19*th*, at 6·30 P. M., the heavens presented a curtain or canopy of auroral light; streamers of yellow, green and crimson were sent up in rapid succession from the horizon to the zenith, where they formed a cupola or corona near *α Aurigæ*; at the horizon, the arch extended from E. to N. W. Stars of the 4th and 5th magnitude were visible through these magnificent curtains of auroral light. These appearances lasted about 30 minutes, and then gradually faded away, as if to seek a rest, and to shine forth with still greater splendor; for at 10 P. M., the northern horizon presented a low auroral arch of a yellow color, while in the southern horizon stretching from E. to W., a most splendid display of streamers rose to an apex, about 60° above the horizon; the streamers were of the same color, as in the former part of the evening; these appearances lasted 20 minutes; the northern arch remained still visible. Volta's No. 1, electrometer, marked 0·76 positive electricity; there was no change indicated, during, or after the phenomenon.—20*th*, 10 P. M. Low auroral arch in the north, very faint; sky clear.

March 7th, 7 P. M. Faint aurora, occasional streamers; sky clear.—19*th*, 10 P.M. Low auroral arch, bright; sky clear.—20*th*, 9 P. M. Faint auroral arch; sky clear.

April. No aurora observed this month.

May 5*th*, 10 P. M. Faint auroral patches, sky clear.—6*th*, 10 P. M. Faint auroral arch; sky clear.—18*th*, 10 P. M. Faint auroral arch, horizon clouded.

June 11*th*, 8·45 P.M., the heavens presented an auroral arch 3° broad of great magnificence; the arch commenced in the E. at the horizon, stretching to the zenith, and descending nearly due west to the horizon; the color was crimson, at other times pale green; the borders or edges were well defined. Stars of the 4th and 5th magnitudes, were distinctly visible through it; a few *light cirri* were discernible in the eastern horizon, but otherwise the sky was clear; a faint auroral light was visible in the north. The arch vanished at 9·20 P. M. The electrometer marked 0; wind west, velocity 1·10 miles per hour.—15*th*. Low auroral arch from E. to W. N. W., bright yellow color; occasional streamers to the zenith, from 9·40 to 11·10 P. M.—23*d*, 11·40 P. M., faint auroral light, sky clear.

July 5*th*, 10 P. M. Auroral bow stretching from E. to W. N. W., 2° wide and bright; sky clear. Wind south, velocity 0·12 miles.—6*th*, 10 P. M. Auroral light in the north, moderate brightness; streamers; sky clear.—7*th*, 10 P. M. Patches of auroral light, or clouds from E. N. E. to W. S. W., which vanished leaving a broad auroral arch; sky clear.—10*th*, 10 P. M. Auroral streamers, bright. *Cumul. Strat.* 4. 20*th*, 9 P. M. An arch of light auroral clouds, 1° in width, passing through the constellations Cygnus, Lyra and Hercules to the horizon, lasted 20 minutes, sky clear, wind S. W., velocity 6·26 miles.—29*th*, 8 P. M. Auroral arch bright. *Cumul. Strat.* 3. Heat lightning very vivid.

August 5*th*, 10 P. M. Very faint auroral light. *Cirr. Cuml.* 4.—6*th*, 10 P. M., do. *Cuml. Strat.* 4.—10*th*, P. M. Bright auroral arch broad; dark segment underneath; sky clear.—11*th*, 10 P. M. Faint auroral clouds in the north; sky clear.

September 3*d*, 10 P. M. Faint auroral light; sky clear.—4*th*, 10 P. M., do.—16*th*, 10 P. M. Bright auroral arch, extended and sending up occasional streamers; sky clear.—17*th*, 10 P. M. Faint auroral arch, low, sky clear; 18*th*, 10 P. M., do.—29*th*, 10 P. M. Floating auroral clouds, varying in brightness; sky clear.

October 6*th*, 10 P. M. Masses of auroral clouds in north of moderate brightness. *Cirr. Cuml.* 4.—19*th*, 10 P. M. Auroral arch faint and low. *Stratus* 2.—20*th*, 9 P. M. Faint auroral arch, with dark segment underneath, at 9·20, a fine display of streamers; sky clear.

November 11*th*, 10 P. M. Bright auroral streamers, not very extended; sky clear.

December 1*st*, 3 A. M. Auroral light in the north, bright and extended; sky clear.—29*th*, 10 P. M. Low auroral arch; sky clear.

Lunar halos visible on six nights. A *lunar rainbow* was also visible on the 29th February. *Fogs* were observed on six mornings. *Shooting stars* were seen on the 18th of July and 9th and 10th of August. A slight shock of an *earthquake* was felt on the

11th of February at 5·40 A. M., barometer 29·067, thermometer 38·5, wind E. by N., velocity 6·00 miles per hour; the *wave* came from the W. N. W. The barometer continued to fall until 11 A. M., it was then 28·892 accompanied by slight rain (0·50 inch); the wind veared about noon by the N. to the W. S. W., and increased to a velocity maximum 30·57 miles per hour, which continued during the day following; wind W. N. W.

Electrical state of the atmosphere.—The atmosphere has afforded indications of electricity, varying in intensity on every day or nearly so, during the year, and was *generally* of a *positive* or *vitreous* character. Two remarkable *electrical storms* occurred on the 23d and 31st of December, indicating an intensity of 450° in terms of Volta's electrometer, No. 1: sparks of $\frac{5}{40}$th of an inch were constantly passing from the *conductor* to the *discharger* for several hours each day: it was of a *positive* character, with frequent and quick changes to negative electricity. An increase of intensity is always observed during the snow storms of our winter; this increase generally possesses the character of positive electricity, although frequent signs of negative electricity have been observed here; this change from positive to negative electricity appears to be connected with change in the form of the crystals of snow. The crystals of snow in this climate during the very severe weather, are generally those described by Scoresby, and figured from 16 to 20 in Kæmtz's Meteorology, also fig. 3; and plain hexagonal prisms have likewise been observed.

St. Martin, Feb. 1, 1853.

ART. X.—*Mr. Blake's Reply to Mr. Hendrick's Review of his article on the Flow of Elastic Fluids.*

THE following will be found to be a sufficient answer to the criticism of Mr. J. E. Hendricks, in the last number of this Journal, upon my article on the flow of elastic fluids published in No. 12, vol. v, second series, of this Journal.

When Mr. Hendricks expresses the pressure by Pt, he should also express the quantity discharged by VDSt. He may then eliminate t and obtain an expression identical with my own, whether the value of t be *cypher* or unity or any other quantity. Hence there is no ground for the distinction he would make between "*momentary*" and other forces.

I avail myself of this opportunity to direct attention to an error of the engraver of the plate which illustrates the results of my experiments on the flow of elastic fluids, at page 191, vol xii, second series, of this Journal. The figures at the left of the plate (18, 19, 20, &c.) should all be moved upward so as to bring the number 30 against the upper line of the plate.

Art. XI.—*Contributions to Mineralogy*; by Dr. F. A. Genth of Philadelphia.

1. *Tetradymite.**—The uncertainty in regard to the chemical constitution of tetradymite renders it desirable, that this mineral should be re-analyzed in order to ascertain, whether it may be considered a tertellurid of bismuth, in which a variable quantity of tellurium is substituted by sulphur, or a combination of one equivalent of tersulphid with two equivalents of tertellurid of bismuth. Several years ago I discovered this rare mineral at a new locality, viz.: Davidson County, N. C., about five miles west of Washington mine.

It occurs there in foliated scales and lamellar masses of splendent metallic lustre, and between lead- and steel-color. H. =1·5; sp. gr. =7·237 (at 7° Cels.).

B.B. on charcoal it fuses readily, tinging the flame blue and giving off the odor of sulphurous acid and slightly that of selenium, leaving white incrustations with a yellow ring next to the substance. In an open tube it gives off white fumes and a sublimate of tellurous acid.

Only a few specimens came from this locality, and as they were found near the surface, a great portion of the tetradymite was already oxydized. This oxydized portion contains but a small quantity of carbonate of bismuth; the greater part seems to be a combination of tellurous acid with teroxyd of bismuth, and, as it yields chlorine when dissolved in hydrochloric acid, some of the tellurium is oxydized into telluric acid.

The accompanying minerals are gold, copper pyrites, magnetic iron, brown hematite, epidote, quartz, etc.

The substance for analysis was first treated with very diluted hydrochloric acid, in order to free it from the oxydized minerals, and then picked out. The pure scales were washed and dried. 0·9039 grms. were dissolved in nitrohydrochloric acid, and the sulphuric acid formed in this manner precipitated by chlorid of barium; the sulphate of baryta was filtered and first washed with diluted hydrochloric acid, finally with water. The dry sulphate of baryta was powerfully ignited, and after cooling, digested with diluted hydrochloric acid, filtered, washed and weighed. It was 0·4064 grs. This precaution, though not generally in use, is of the greatest importance for a correct determination of sulphuric acid (resp. sulphur) in all cases in which nitric acid is also in solution. It is well known, that in its presence a large portion of nitrate of baryta always falls down along with the sulphate of baryta. This nitrate of baryta cannot be washed out completely,

* An abstract of this paper was published in Keller-Tiedemann Nordamerikanischen Monatsbericht, ii, p. 249.

not even with boiling water; the best mode to get such sulphate of baryta pure is to decompose the nitrate of baryta by heat, and to extract the caustic baryta afterwards with diluted hydrochloric acid.

After freeing the filtrate from the excess of chlorid of barium by sulphuric acid, the solution was treated with hydrosulphuric acid, and from the precipitate thus obtained, tellurium was separated by digestion with sulphid of ammonium. The filtrate containing it, was evaporated nearly to dryness and oxydized with nitrohydrochloric acid, the nitric acid removed by evaporation with an excess of hydrochloric acid and the tellurium then precipitated by bisulphite of ammonia. This metal filtered upon a filter of known weight was found to be 0·3000 grs.

The precipitate of tersulphid of bismuth was dissolved in nitric acid and precipitated from the boiling solution by carbonate of ammonia. The carbonate after ignition gave 0·6067 grs. teroxyd of bismuth. The filtrate of the mixed precipitate of the sulphids of bismuth and tellurium was oxydized by nitric acid and the sesquioxyd of iron precipitated by ammonia. It was 0·0115 grs. The iron being an impurity in tetradymite was calculated as iron pyrites and subtracted from the original weight. Thus the analysis gives as the composition of this tetradymite:

Bi 61·351 Te 33·837 Se *trace* S 5·270=100.458

$$\frac{61{\cdot}351}{207{\cdot}996} : \frac{33{\cdot}837}{64{\cdot}141} : \frac{5{\cdot}270}{16{\cdot}060} = 0{\cdot}295 : 0{\cdot}528 : 0{\cdot}308$$

This ratio does not very well correspond with the formula $BiS_3 + 2BiTe_3$, for which the calculated per-centage would be:

Bi 59·033 Te 36·409 S 4·558

The analyses of the tetradymite from Schubkau in Hungary, by Berzelius and Wehrle, and that of the same mineral from Whitehall in Virginia by C. T. Jackson, (the latter after subtraction of gold, &c.) give:

	Berzelius.	Wehrle.	C. T. Jackson.
Bi -	58·30	60·0	60·31
Te -	36·05	34·6	35·95
S -	4·32	4·8	3·74
	98·67	99·4	100·00

It will be seen, that Berzelius's analysis accords better with the above formula than that of Wehrle, and that mine is very similar to the latter.

I will now compare these analyses with the formula $Bi(Te, S)_3$, considering the quantity of tellurium as correct. After calculating for it the requisite quantity of bismuth to form $BiTe_3$, I take the difference as BiS_3 and get in this manner the following per-centages:

	Genth.	Wehrle.	Berzelius.	Jackson.
Bi -	61·19	60·7	60·07	59·33
Te -	33·84	34·6	36·05	35·95
S -	4·97	4·7	3·88	4·72

My own and Wehrle's analyses speak decidedly in favor of the latter formula, and even Berzelius's analysis shows but a slight difference in respect to bismuth and sulphur.

The composition of tetradymite therefore appears to be $Bi(Te, S)_3$; but it cannot be regarded as a settled question, since we have only a few analyses of this rare substance which allow of a fair calculation. Jackson's analysis is deficient either in sulphur or in tellurium, and the 60·31 p. c. of bismuth require 1·23 p. c. of sulphur (or an equivalent quantity of tellurium) more than he found, in order to have 3 equivalents of the electro-negative elements in combination with one of bismuth. In regard to selenium my experiments agree with those of Dr. Jackson. Before the blowpipe it gives off fumes of sulphurous acid quite distinctly, and judging from the intensity of the horse-radish odor, there cannot be a large quantity of selenium in the mineral.

Dr. Jackson remarks, that he observed impressions of the edges of crystals of tetradymite in metallic gold. I have in my cabinet a magnificent specimen of native gold from Whitehall, which appears to be a pseudomorph of tetradymite. I intend making a thorough examination of it and will describe it as soon as I find leisure to do so.

2. *Gray Copper* (probably a new mineral*).—At McMackin's mine, Cabarras County, N. C., I found a mineral associated with carbonate of magnesia, talc, blende, iron pyrites and galena, which is closely allied to some argentiferous gray coppers. As no locality in the United States of a similar mineral has yet been made known, an examination of it, I thought, might give interesting results.

Massive, apparently without any crystalline structure: H. = 4·5; sp. gr. ? —; color nearly iron black, subtranslucent, when in very thin splinters with cherry-red color; streak brownish-red; lustre submetallic; fracture conchoidal; brittle.

B.B. on charcoal it fuses readily = 1, makes incrustations of antimony and zinc, and gives off the odor of arsenic and sulphurous acid; with carbonate of soda on charcoal yields a globule of silver and copper. Soluble in nitrohydrochloric acid with separation of chlorid of silver.

0·1330 grs. were dissolved in nitrohydrochloric acid, the liquid diluted with a large quantity of water, and the chlorid of silver filtered off. It gave 0·0140 grs. silver. The filtrate was almost evaporated to dryness, the arsenic acid reduced by bisulphite of ammonia, the excess of the latter decomposed by hydrochloric acid, and copper, arsenic and antimony precipitated by hydrosulphuric acid. The precipitated sulphids were filtered and treated

* Read before the Acad. of Nat. Sci. of Philad., Feb. 15, 1853.

with sulphid of ammonium. The remaining sulphid of copper was dissolved in nitric acid and the oxyd of copper precipitated from the boiling solution by caustic potash. It gave 0·0512 grs. The filtrate from the sulphid of copper was saturated with hydrochloric acid and the precipitated sulphids of arsenic and antimony oxydized by chlorate of potash; chlorid of ammonium, tartaric acid and ammonia were added, and the arsenic precipitated by sulphate of magnesia as arseniate of magnesia and ammonia. This precipitate contained 0·008 grs. of magnesia.

The filtrate from the precipitate by hydrosulphuric acid gave, after having been oxydized by nitric acid, 0·0027 grs. sesquioxyd of iron, precipitated by ammonia; the filtrate from it gave with sulphid of ammonia a precipitate which yielded 0·0042 grs. of oxyd of zinc.

Sulphur and antimony were determined from the loss and by calculation. The analysis gave:

Ag	10·53	p. c.	which require	1·57	sulphur for	Ag S	11·43
Cu	30·73	"	"	7·80	"	Cu_2 S	
Zn	2·53	"	"	1·25	"	Zn S	
Fe	1·42	"	"	0·81	"	Fe S	
As	11·55	"	"	7·42	"	$As S_3$	14·05
Sb	17·76	"	"	6·63	"	$Sb S_3$	
S	25·48	"					
	100·00			25·48			

The ratio of sulphur of the sulphobasis and sulphoacids is: 11·43 : 14·05 or 1 : 1·23, corresponding with the formula,

$$5(Ag, Cu_2, Zn, Fe)S + 2(As, Sb)S_3$$

It will be seen that this composition differs from that of gray copper, which is $4(Ag, Cu_2, Zn, Fe)S + (As, Sb)S_3$. As I had but a small quantity of this mineral for analysis, I prefer describing it at present as a variety of gray copper until further experiments prove that they are different.

3. *Apophyllite.*—The analyses of apophyllite from different localities show such a difference in the quantity of fluorine present (varying from 0·34 to 1·54 p. c.), that Rammelsberg suggested it might be a silicate in which a part of the oxygen is replaced by fluorine.

Mr. Edwin L. Reakirt analyzed in my laboratory the beautiful apophyllite from the Bay of Fundy, Nova Scotia.

It is known, that several varieties of apophyllite readily undergo a change in appearance, somewhat similar to that of Laumonite. In all the specimens which I had a chance to examine, it began with the octahedral faces, which became white and opaque, like semi-opal, whilst often the greater portion of the crystals remained vitreous and unchanged. Bergen Hill, N. J., afforded many specimens of this kind. I am not aware that investigations have ever been made in order to determine, whether the opaque and

vitreous apophyllite has the same composition, thus indicating dimorphism, or whether it is a pseudomorph in the form of apophyllite, caused by a commencing decomposition of the latter. Some of the differences in previous analyses may be attributed to a want of care in separating the opaque from the vitreous portion.

The material for Mr. Reakirt's analyses came from a large crystal, which was perfectly vitreous and not in the least decomposed. The form of the crystal was the square octahedron with the second prism.

The powdered mineral was dried over sulphuric acid.

I. 1·1671 grs. mixed and covered with freshly ignited oxyd of lead lost by ignition 0·1945 grs. of water.

II. 3·8700 grs. were fused with carbonate of soda, the fused mass was digested with water and filtered from the residue. This was dissolved in hydrochloric acid, the silicic acid separated by evaporation to dryness. The dry mass was moistened with hydrochloric acid and the silicic acid (*a*) filtered. The filtrate from the watery solution containing also a considerable portion of silicic acid, was precipitated by carbonate of ammonia and the silicic acid (*b*) filtered and weighed with the other portion: *a* and *b* weighed 2·0321 grs.

From the filtrate of silicic acid (*b*) a mixture of fluorid of calcium and carbonate of lime was precipitated by chlorid of calcium. Both were filtered, and after being ignited, treated with acetic acid, the excess of acetic acid evaporated in a water-bath and the insoluble fluorid of calcium separated from the acetate of lime by boiling water. It gave 0·1438 grs.

Lime was precipitated from the filtrate of silicic acid (*a*) by oxalate of ammonia and ammonia, which precipitate gave 1·7234 grs. carbonate of lime.

III. 1·4570 grs. were fused with carbonate of soda and the fluorid of calcium determined as in II. It gave 0·0491 grs.

IV. 1·9708 grs. were dissolved in hydrochloric acid and evaporated to dryness; the dry mass was moistened with hydrochloric acid and filtered. The silicic acid, thus obtained with addition of a small quantity from the silicofluorid, weighed 1·0384 grs.

The filtrate from the silicic acid was precipitated by ammonia and the small quantity of silicofluorid of calcium fused with carbonate of soda. The silicic acid was determined as in II (*b*), and added to that separated by hydrochloric acid. The lime was also added to the other portion of it. The filtrate from the silicofluorid was precipitated by oxalate of ammonia. It gave 0·8484 grs. carbonate of lime.

The filtrate was evaporated to dryness and the ammoniacal salts driven off by heat. The residue was acidulated with a little hydrochloric acid to convert the carbonate of potash which on

heating with oxalate of ammonia is always formed, into chlorid of potassium, evaporated, heated and weighed. It gave 0·1602 grs. chlorid of potassium. The composition of this apophyllite is therefore:

		I, II and IV.	I, III and IV.	Mean.		
SiO_3	- -	52·51	52·69	52·60	contains oxygen	27·18
CaO	- -	24·99	24·77	24·88	"	7·08
KO	- -	5·14	5·14	5·14	"	0·87
Fl	- -	1·79	1·63	1·71		
HO	- - -	16·67	16·67	16·67		14·81
		101·10	100·90			
Oxygen equiv. with Fl =		0·76	0·69			
		100·34	100·21			

Not taking any fluorids into calculation but their equivalent oxyds, the ratio of oxygen, $KO:CaO:SiO_3:HO = 0·87:7·1:27·1:14·8$ or almost exactly what Berzelius found, 1 : 8 : 30 : 16 giving the formula $KO, 2SiO_3 + 8CaO, SiO_3 + 16HO$.

It is not improbable that a variable quantity of oxygen may be replaced by fluorine and that the general formula is:

$$K(O, Fl), 2Si(O, Fl)_3 + 8Ca(O, Fl), Si(O, Fl)_3 + 16HO.$$

4. *Allanite* from Orange County, N. Y.—I find a statement in Dana's Mineralogy, p. 681, based upon an analysis of T. H. Garrett, that the massive pitch-black mineral from Orange County, which had been considered an allanite, did not contain any cerium. I am indebted to W. S. Vaux, Esq., for a specimen from this locality. Mr. Edw. L. Reakirt analyzed it in my laboratory and found that it contains both oxyds of cerium and lanthanum. After the silica and alumina were separated as usual, the residue, insoluble in caustic potash, was boiled with oxalic acid and the white crystalline precipitate filtered after cooling. This oxalate on ignition yielded a reddish brown oxyd, from which nitric acid, diluted with about 200 parts of water, extracted a small quantity of lanthana. The remaining oxyd gave all the characteristic reactions of cerium. The mineral from Orange County is therefore allanite.

(*To be continued.*)

ART. XII.—*Review of the Geological Report on Wisconsin, Iowa and Minnesota, and incidentally of a portion of Nebraska Territory.*

IN our March number of this year, we gave a brief bibliographical notice of this work, soon after it issued from the press; but being the final Report of an important and very extensive geological exploration of the Northwest, commenced in 1847 by Dr. D. D. Owen, United States Geologist, we intended, hereafter, to give a more extended review of the important geological facts and practical results than our space then admitted. This we

now proceed to do in as succinct a manner as the interest of the subject permits, premising with a few remarks on the general appearance of the work.

The text is comprised in a handsome quarto of 638 pages, interspersed with upwards of 140 wood-cuts, 70 of which are geological scenes of particular interest; the rest local sections. They are amongst the best wood-engraving this country has produced, and eminently calculated to convey a vivid impression of the rocky scenes and geological phenomena they are intended to illustrate, and contribute greatly to the interest of the subject.

An Atlas of plates accompanies the text and contains 27 steel-plate engravings of the most characteristic fossils of each of the formations found in the District, from the oldest fossiliferous strata, to the Eocene tertiary, 18 large plates of sections and profiles of heights, nine of which are on steel and nine on stone. Five of the largest sheets of sections have the topography of the principal streams plotted, in connection with the sections, which add greatly to the interest of the geological features, as well as to a correct appreciation of their geographical position. There are also two quarto maps on steel; one showing the position of the Eocene Tertiary Basin of Nebraska; and the other, which is colored to represent the extension of the geological formations under the vast drift deposits of the interior. The geology of the entire region, together with the approximate boundary of the extension of the Iowa coal field through Missouri, is united on a large colored map, 28 inches by 48.

The engravings on steel, representing the organic remains, deserve particular notice for their admirable faithfulness and beauty of execution. We understand that ten of them, viz.: Tab. I, I A, I B, I D, II A, II B, III A, VII, VIII and VIII A, have been executed by a new style of *machine* engraving, similar to that adopted for the representation of medals, and described by Dr. Owen as follows. "The fossil itself serves as a guide and model to work from. After the specimen is fixed permanently on the machine, one arm, pointed with steel, traverses all its inequalities of surface, in close, parallel, waving lines, and imparts a corresponding movement to a diamond point, in contact with the steel plate, which cuts similar lines through the prepared asphaltum surface down and slightly into the steel plate; subsequently these lines are corroded deeper—in the language of the engraver, bitten—into the metal by means of dilute nitric acid. Thus is produced an engraving, in a delicate silvery effect of light and shadow, capable of giving, if desired, 100,000 impressions of as perfect a counterpart of the original as can be accomplished by the daguerreotype process, provided the subject has not *too great relief* and can be placed in a horizontal position in the machine."

"Though the plates in this work are the first application of this art to the representation of fossil remains, it has been a won-

derfully successful experiment which will doubtless be the means of its introduction whenever the form and character of the subject admits of its application. All structure visible to the naked eye can be brought out by this process; and even minuter structure, indistinctly visible to the unassisted eye, can be worked up by a skillful artist, after the plate comes from the machine, as may be seen by inspecting figs. 4, 11, 13 and 20 of Tab. IIB, and figs. 16, 19, and 21 of Tab. IIIA."

The plates engraved from daguerreotypes of the originals are also admirably executed, especially Tab. XII, XIIA, and XIIB. Altogether we have seldom, if ever, seen engravings which present so life-like an effect, if such an expression be admissible, in figures of fossil remains.

The first chapter of the Report embraces a description of the protozoic or most ancient fossiliferous strata belonging to the palæozoic period. The developments in regard to the organic contents of these rocks, in the valley of the Mississippi, are amongst the most important discoveries and contributions of the survey in a scientific point of view.

On this head we extract the following:

"It had been usually believed, up to the date of my Annual Report of 1848, that the lowest members of the sandstone formation of which I am now speaking, were devoid of fossils. The geologists of our own country had set down the Lingula beds of the New York Potsdam Sandstone as the oldest fossiliferous rocks in the United States. And, in Europe, with the exception of the *Obolus Appolinis* of Eichwald, abundantly found in the inferior sandstones of the protozoic strata of Russia, no fossils whatever (according to any established system) had been described or discovered beneath what has been usually regarded as the equivalent of the above-named Lingula beds. I am now able to exhibit a new and interesting geological feature with regard to this formation.

The present survey has brought to light the fact, that in Western America are found strata underlying coarse Lingula grits, and at a depth of seventy-five to one hundred feet beneath them, which are highly fossiliferous, and contain not the *Lingula* and *Obolus* alone, but *Orbiculas*, *Trilobites*, and compressed subconical bodies, resembling some forms of *Cephalopoda*, but probably not actually of that order. The sedimentary stata, in which, on the Mississippi and most of its tributaries, these fossils occur, either rest immediately on the igneous rocks of Wisconsin, or are separated from them by an inconsiderable thickness of chlorite and ferruginous slates; and are, in all probability, the oldest fossil-bearing rocks yet brought to light in any part of this Continent, if not of the world.*

* In the chloritic and ferruginous slates here metioned no organic remains have been discovered. In these rocks I am unable to trace any analogy, in lithological character, to Professor Emmons's "Taconic System." Whatever may occur elsewhere, it does not appear that in the Valley of the Upper Mississippi, any fossil-bearing rocks, deserving the name of a distinct system, occur intervening between the igneous rocks and the base of the sandstones belonging to the Silurian period.

Without assuming to determine the much-disputed question of an absolute *palæozoic base*, it may be safely asserted that the fossiliferous strata above referred to, exhibit the true base of the zoological series in the Mississippi Valley.

It was in August of 1847, while descending the St. Croix, that I first observed multitudes of *Lingulas* and *Orbiculas* disseminated in strata abutting against the protruding trap ranges which cross the stream at its falls. In tracing out the geological position of these strata, during the succeeding months of the same year, I usually found them either, as in the above instance, in almost immediate contact with the trap or granite, or else separated from these only by the lowest member of F. 1. Their depth below the base of the Lower Magnesian Limestone, I found to be not less than five hundred feet.

I observed, also, that besides *Lingulas* and *Orbiculas*, there occurred in the sandstones of this formation, (above the *Lingula* grit, however) other *Brachiopoda* and several forms of *Crinoidea*, found in peculiar green dolomitic interpolations.*

In October of the same year, while measuring sections on the Mississippi, between the Falls of St. Anthony and the mouth of the Wisconsin, I discovered within a few feet of low-water mark, ten miles below Mountain Island, on the west side of the Mississippi, laminated grits and siliceo-calcareous layers, charged with an *Obolus*, probably identical with that occurring in the inferior sandstones of Russia; and from some of the very lowest of these, I collected specimens of a peculiar Trilobite, remarkable on account of the spines with which it is provided, projecting backwards from the margin of the pygidium.

Convinced that the formations of Iowa and Wisconsin were destined to divulge new facts relative to the palæozoic base in Western America, I caused to be instituted, during subsequent surveys in 1848, 1849, and 1850, minute stratigraphical and palæontological sections at every favorable locality. The result showed, beneath the Lower Magnesian Limestone, at least six different Trilobite beds, separated by from 10 to 150 feet of intervening strata.

I communicated this fact, in general terms, in my Preliminary Report of October 11, 1847, and more at large in my Annual Report for 1848, published in the spring of 1849.

The largest species of *Trilobite* obtained in this formation, and which I have named *Dikelocephalus*, is figured on Plate I, fig. 1. It occurs a few feet above the water level on Lake St. Croix, imbedded in a species of hydraulic limestone (the fifth Trilobite bed), near the top of member *d*, of F. 1.

* The analysis of a coarse, buff, crystalline variety of these beds, is as follows:

Moisture,	0·40
Insoluble earthy matter,	2·74
Carbonate of lime,	48·24
Carbonate of magnesia,	42·43
Protoxyd of iron, with a trace alumina,	6·14
Loss,	0·05
	100·00

Many of the fossiliferous beds of this formation are densely crowded with organic relics; as much so as the most fossiliferous of the blue limestones of Ohio, Indiana, and Kentucky. The proportion of genera and species, it is true, is not great, but the number of individuals is immense; some slabs are so covered with shells, that it would be difficult to place the finger on a spot without touching some of them.*

If we except the white sandstone, the uppermost bed of F. 1 *e*, that upon which the Lower Magnesian Limestone (F. 2) rests, nothing definite was known, up to the period of the present survey, of the nature or character of the underlying beds just described; neither had any well-defined organic remains been described anywhere beneath the gray and blue fossiliferous beds which form the upper portion of the sections at Prairie du Chien; so that there was an entire absence of all palæontological evidence as to the exact place which these strata occupied in the Western geological series. It is, therefore, with no small degree of satisfaction that I find myself able to disclose a new feature in the palæontology of Western America, and thus to furnish, not only to the geologist a key to the stratigraphical position of the rocks north of the Wisconsin River, but, at the same time, to the miner his surest and safest guide by which to direct operations in the search after mineral wealth."—pp. 51–52.

The immense extent of the protozoic rocks chiefly belonging to its lower division seems to be a remarkable feature of the geology of the Northwest. The area of the "Lowest Sandstone" where it is fairly exposed cannot be less than 12,000 square miles; and that concealed by drift at least as much more, within the confines of the United states. These sandstones attain a thickness in the best exposed sections on the Mississippi and Wisconsin rivers of upwards of 500 feet. The calcareous beds of the same period are fully as extensive. Commencing on the Mississippi in lat. 41° 30′, they prevail to the Wisconsin and Turkey rivers, and thence capping the above-mentioned sandstones, they stretch, with little interruption, on both sides of the Mississippi, to within a few miles of the Falls of St. Anthony; thence up the valley of the Minnesota river, nearly to its confluence with the Lesueur river; and after being lost under the drift, they reappear at the Great South Bend of Red river of the North, at Lower Fort Garry and Great Lake Winnepeg.

The *upper* magnesian limestone has, in the valley of the Mississippi River, south of Wisconsin and Turkey rivers, a length from north to south of nearly 100 miles, and even a greater width from east to west, giving an area of at least 11,000 square miles. North of Wisconsin and Turkey rivers to the St. Croix valley, the *lower* magnesian limestone has a length from northeast to southwest of 160 miles, with an average width of nearly 50 miles, giving an area of 8000 miles, and this without its extension in the valley of Red River of the north, and under

* See Tab. 1, B. Fig. 1.

the drift. And what is remarkable, these calcareous rocks, throughout this vast range, are, for the most part, highly charged with magnesia, containing from 15 to 20 per cent. of this earth.

These magnesio-calcareous beds, more than any other formation, impress upon the landscape the peculiar picturesque scenery so characteristic of the Upper Mississippi country in Wisconsin and Iowa. They are moreover the lead-bearing rocks of these States, from whence so much mineral wealth has been derived. From the recorded statistics in the table on page 61, it appears that the veins of Galena, worked in the upper magnesian limestone, in the Mineral Point district of Wisconsin and part of the Du Buque district of Iowa, yielded in 1847 upwards of fifty-four millions of pounds of lead, and, as it is justly remarked, this amount would undoubtedly have been much increased up to the present time, but for the inducements offered to miners to emigrate to California.

The whole of these two vast formations—as well siliceous as calcareous—with the exception of the coralline and pentamerus beds, are referred to the lower Silurian period of Murchison. The upper and lower Magnesian limestone formations are separated by a subordinate bed of sandstone, varying from 40 to 100 feet in thickness, often composed of limpid grains of quartz, upon which rest two beds of fossiliferous limestone with a non-fossiliferous band intervening. In all 30 to 40 feet in thickness. Analyses showed the lowest of them to be the purest limestone of the Upper Mississippi country, containing only between six and seven per cent. of magnesia. These layers lie at the base of the upper magnesian limestone formation, and are described as richer in organic remains than any of the overlying or underlying beds. Many of the species are identical with those occurring in the blue limestones of the Ohio Valley and the Trenton limestone of New York.

The 2d chapter is devoted to the formations belonging to the Devonian period, which are confined chiefly to the valley of Cedar River and its tributaries. They consist mostly of pure calcareous rocks which underlie the prairie country between the waters of the Wapsipinicon and the upper two-thirds of the Iowa River; and sustain a most productive and retentive soil, well adapted for wheat and small grain. The land is gently rolling and affords every facility to the farmer for the introduction of labor-saving machinery in his sowing and harvest operations, even at the first opening of a farm; since the ground is never incumbered with stumps, which form a serious obstruction in the newly cleared forest lands of Ohio and Indiana.

The lower beds of this formation appear, from the specific character of the organic remains, to correspond in age to the Onondaga limestone of New York; the upper to the Hamilton Group.

The carboniferous rocks which form the subject of the 3d chapter, lie southwest of the above formation, occupying nearly the whole of the remaining portion of Southern Iowa, and extend from the Mississippi across to the Missouri.

The coal-measures, without the circumscribing belt of carboniferous limestone, occupy in Iowa alone 25,000 square miles, extending no less than 200 miles in a direct line up the Des Moines, which river flows diagonally through the heart of that portion of the coal-field which is situated in Iowa. The same coal-field stretches into Missouri, in which state it has at least as great an area.

The coal measures are underlaid by a great zone of sub-carboniferous limestone, the average width of which may be 20 to 25 miles, except in the extreme northeast, where the sandstones of the coal formation abut immediately on the limestone of Cedar Valley.

The sub-carboniferous limestone is described as having a greater thickness than the coal-measures proper, which are only some 300 feet, while the underlying limestones are at least 400 to 500 feet in Iowa, and much thicker farther south in Missouri.

The coal is mostly of the slaty varieties of bituminous coal; the beds varying from a few inches to 4½ or 5 feet. They are included in the shaly argillaceous division of the lower third of the formation. There are beds of greater thickness farther south in Missouri, at the southern margin of the same coal-field.

Under the head of "Physical and Agricultural character" of the carboniferous rocks of Iowa, the author makes the following remarks:

"The carboniferous rocks of Iowa occupy a region of country, which, taken as a whole, is one of the most fertile in the United States. No country can present to the farmer greater facilities for subduing in a short time wild land. Its rich black soil, scarcely less productive than that of the Cedar Valley, returns him reward for his labor a hundredfold. The only drawback to its productiveness is that, on some of the higher grounds, the soil, partaking of the mixed character common to drift soils, is occasionally gravelly; and that here and there, where the upper members of the coal-measures prevail, it becomes somewhat too siliceous.

The rural beauty of this portion of Iowa can hardly be surpasssd. Undulating prairies, interspersed with open groves of timber, and watered with pebbly or rocky-bedded streams, pure and transparent; hills, of moderate height and gentle slope; here and there, especially towards the heads of the streams, small lakes, as clear as the rivers, some skirted with timber, some with banks formed by the greensward of the open prairie;—these are the ordinary features of the pastoral landscape.

For centuries, the successive natural crops of grass, untouched by the scythe, and but very partially kept down by the pasturage of buffalo and other herbivorous animals, have accumulated organic matter on

the surface soil to such an extent, that a long succession, even of exhausting crops, will not materially impoverish the land. The prairie-sod, matted and deep-rooted, usually requires from six to eight yoke of oxen effectually to break it up.

The future farms of Iowa, large, level, and unbroken by stump or other obstruction, will afford an excellent field for the introduction of mowing and reaping machines, and other improved implements calculated to save the labour of the husbandman; and which, in new countries reclaimed from the forest, can scarcely be employed until the first generation shall have passed away.—pp. 100, 101.

The immediate basin of Lake Superior is formed of red sandstones and argillaceous beds, conglomerates and shales overlaid and concealed to a great extent by superficial deposits of red clay, marls and drift; and intersected especially on the northwest shore by a multitude of igneous outbursts which have modified altered and indurated the adjacent strata, and tilted them locally in different directions from the prevalent gentle southeasterly dip. The mechanical action and metamorphism which have resulted, have produced the amygdaloids and conglomerates which usually intervene between the red sandstones and dykes of trap.

The detailed descriptions of these interesting formations are given chiefly in the reports of Dr. J. G. Norwood, and those of Col. Whittlesey; the field of operation of the former gentleman having been principally in middle, northern, and northeastern Minnesota, that of the latter, along the southern watershed of Lake Superior, situated between the Michigan line and the Bois Brulé River.

The 4th chapter contains some additional details regarding the other portions of the interior of Wisconsin, Minnesota and the valley of Red River of the north, for which we must refer our readers to the work itself.

The crystalline rocks and metamorphic schists first appear on the surface about lat. 44° 20′, and occupy, under the superficial deposits, a considerable area in the northern and eastern portion of the district, both N. W. and S. E. of Lake Superior; but the actual surface exposures are limited, inasmuch as the drift deposits have filled up most of the inequalities of the surface, and thus conceal to a great extent the hypogene rocks and crystalline schists, and, at the same time produce a uniformity and levelness of surface which would hardly be anticipated on approaching the sources of such important streams as the tributaries that give origin to the mighty Mississippi. Even the igneous rocks, forming the summit levels, 500 to 1000 feet high, dividing the waters flowing into Lake Superior, and those running into the Mississippi, are, for the greater part of their range, buried beneath heavy drift deposits. The country around the sources of the Wisconsin, Chippewa, St. Croix, St. Louis and Mississippi are described as of this character.

The 5th chapter contains a discussion on the age of the red sandstones of Lake Superior, and the evidence from which it is inferred, with great probability, that its *general dip* is southeast, bringing it underneath the Lingula, Orbicula, and Obolus beds of the St. Croix Valley, and that they therefore constitute the strata intervening between these beds and the crystalline schists that repose on the granite.

The incidental observations in the Eocene Tertiary basin of the Mauvaises Terres or Bad Lands of Nebraska and the adjacent cretaceous deposits, are recorded in the 6th chapter from which we have already given extracts in our March number.

The extraordinary fossil mammalia collected during the survey in this region, were submitted for description to the able comparative anatomist, Dr. Joseph Leidy of Philadelphia, whose Report on this branch of the palæontology, will be found commencing on page 539 of the volume.

Dr. B. F. Shumard's report comprises the details of his observations among the protozoic rocks of the Minnesota Valley, and minute stratigraphical and palæontological details of the most interesting sections on both sides of the Mississippi River, from the falls of St. Anthony to the confines of the carboniferous rocks, near Wyoming, as well as on the Wisconsin River, between its mouth and the igneous exposures on Whitney's Rapids.

The Appendix to the report contains the description of new fossil species and genera, collected during the survey from the protozoic rocks, the limestones of Cedar Valley, the carboniferous rocks and the cretaceous deposits, followed by a systematic catalogue of plants collected by Dr. C. C. Parry, in connection with the geological survey, made during the season of 1848; also a systematic catalogue of birds observed by Mr. Pratten, in the northern part of Wisconsin and southern portion of Minnesota. There are also appended tables of the stratigraphical and geographical distribution of fossil of the northwest and the equivalency of strata.

The thanks of the community at large, and especially of the scientific public, are due to Dr. Owen, for his exertions towards presenting the final results of his labors, and those of the other scientific gentlemen who aided him in the undertaking, in so attractive and appropriate a form; having spent, as we learn, the whole of the winter of '51 and '52 at the seat of government, solely with a view of obtaining the sanction of Congress to have this work printed by *special contract* in Philadelphia, under the immediate supervision of the author, and in the style and form he regarded as most suitable for the subject; by which he has been enabled to produce a work creditable to the government under whose auspices the survey was conducted, as well as to all concerned in it; it stands out in strong contrast with

ordinary public printing, which we are sorry to say has, until lately, been very inferior in its typographical execution and quality of paper. And we hope that Dr. Owen's report, as to style of execution, may serve as a standard for all future Congress documents, which embody valuable practical and scientific information for the people; the more especially since the cost per volume, considering the amount of matter and illustration, has actually been much less than had previously been paid for illustrated scientific works got up at the seat of government in the ordinary unworkmanlike —we may almost say careless and slovenly—manner of most public printing.

ART. XIII.—*On the supposed new element, Thalia;* by Prof. J. LAWRENCE SMITH.

ABOUT fourteen months ago the discovery of a new earth was announced by Dr. D. D. Owen, as existing in a saponaceous mineral from the amygdaloidal traps of the north shore of Lake Superior. A few months after the first announcement, I obtained two or three grammes of the mineral from Dr. Owen, and subjected it to analysis without discovering any substance in it that could be called a new element. The results were not made public at the time, as more material was required to arrive at a positive conclusion. It is only lately that, through the kindness of Dr. Genth of Philadelphia, an additional quantity of the Thalite has been obtained, as well as some of the earth called thalia. Both have been examined with great care: the analysis of the former accords with my former analysis, making the Thalite to be *saponite;*—details of the analyses will be given in the third paper on the reëxamination of American minerals. The earth sent as thalia, is *magnesia* mixed with a little lime.

It may be well to state here, that the fact of the precipitation of the neutral solution of the earth by oxalate of ammonia seems to have had considerable weight on the original decision concerning this substance. But it is an erroneous impression that oxalate of ammonia will not precipitate the neutral and even slightly acid solution of magnesia salts, more or less promptly, according to circumstances, a fact not sufficiently insisted on by writers on analytical chemistry; some experiments on this subject will furnish matter for a future article in which it will be shown that precautions are frequently required to separate lime from magnesia by oxalate of lime, when the magnesia is present in considerable quantity. Further remarks on this substance will be made when the analysis of Thalite is given.

Art. XIV.—*On the Isomorphism of Sphene and Euclase;* by James D. Dana.

It is the more common course, in deducing the fundamental form from the crystals of a species, to consider the two directions of most distinct prismatic cleavage, where such exist, as corresponding to the lateral faces of the fundamental prism. The planes *r*, *r*, in Sphene (see the figures in different Mineralogical Treatises) are of this kind; and taking for the base of the prism *r r*, the plane *y*, (a face of composition in twins and therefore of prominent importance,) the relations of the planes in the crystals of sphene become quite simple.

We here give a table presenting the observed planes in accordance with this view. *O* is the basal plane; and below it are the different vertical series. The planes 1, 2, –2, –1, belong to the fundamental series; 1*i*, *ii*, are in the series parallel to the orthodiagonal; 4*i*, *i*, in that parallel to the clinodiagonal: and intermediate are forms of the series, *m*2, *m*3, *m*$\grave{3}$, 12 and 22 being of the first, *i*3 of the second, and 6$\grave{3}$ and –3$\grave{3}$ of the third.*

		O(*y*)			
1*i*(*x*)	12(*w*)		1(*z*)		
	22(*e*)		2(*n*)		
					4*i*(*s*)
				6$\grave{3}$(*u*)	
ii(*P*)		*i*3(*o*)	*I*(*r*)		*i*(*b*)
					4*i*(*s*)
				–3$\grave{3}$(*m*)	
			–2(*t*)		
			–1(*l*)		

The table represents a quarter section of the crystal, and is somewhat analogous to a Mercator's projection of it. The fundamental vertical series is marked off by placing it between heavier lines in the table, and so also the horizontal series of vertical prismatic planes. For the convenience of comparison, we have also given the lettering adopted by others.

* The expressions, as in Naumann's symbols, represent the parameters of the planes, the first figure (or letter) referring to the vertical axis, and the second indicating the ratio between the two lateral axes. In the expression 1 2, the figure 2 means that in the parameters of the planes there is a ratio of *twice* the orthodiagonal to *once* the clinodiagonal; and in 6 3, the 3 indicates a ratio of 3 *times* the clinodiagonal to *once* the orthodiagonal; in the former, the 1 signifies *once* the vertical axis, and in the latter, 6 signifies 6 *times* the same axis. In the planes 1 and 2, the second figure is not expressed, a unit being understood, the ratio between the lateral axes being that of unity; the planes are of the fundamental series. The letter *i* is written in place of the symbol for infinity (∞), and hence *i*3, signifies that the plane is parallel to the vertical axis, and has the ratio between the orthodiagonal and clinodiagonal of 3 : 1; *ii* is parallel to the vertical axis and orthodiagonal; *i* is parallel to the vertical axis and clinodiagonal; *i* (or *I*) is parallel to the vertical axis, and has the ratio 1 : 1 between the orthodiagonal and clinodiagonal, or in other words, it belongs to the fundamental series and is the vertical prism of that series; 1*i* is parallel to the orthodiagonal, and the 1 shows its relation to the vertical axis and orthodiagonal; 4*i* is parallel to the clinodiagonal, and 4 refers to the vertical axis.

The crystals of sphene from northern New York, called Lederite by Shepard, present actually the fundamental form here adopted, with simply a plane on each basal edge (2 or n and -2 or t), and a truncating plane (ii or P) on the front lateral edge.

The inclination of the vertical axis is 119° 33′; and making a the vertical axis and b the clinodiagonal, $a:b:c=0{\cdot}4277:0{\cdot}75414:1$. The interfacial angle $I:I\,(r:r)=113°\ 28'$, $O:1i\,(y:x)=158°\ 55'$, $1:1\,(z)=149°\ 38'$, $2:2\,(n)=136°\ 4'$.

This mode of viewing the crystallization of sphene brings to light an approximate isomorphism of the mineral with Euclase. In euclase $I:I=114°\ 50'$, $O:1i=158°\ 10'$, $1:1=151°\ 48'$. The principal difference in the dimensions of the two is found in the greater length and inclination of the vertical axis in sphene, this inclination being in euclase but 108° 53′. Euclase has also a perfect clinodiagonal cleavage.

In chemical composition, the species are widely different, sphene being a titano-silicate of lime ($2\dot{C}a\,\ddot{S}i+\dot{C}a\,\ddot{T}i^3$), and euclase a silicate of alumina and glucina ($\ddot{A}l^{\frac{1}{2}}+\ddot{B}e^{\frac{1}{2}})^4\,\ddot{S}i^3$.

Art. XV.—*Characters of* Tetraclea, *a new genus of Verbenaceæ;* by Asa Gray, M.D.

The plant which forms the subject of this article first came to my notice in the Texano-New Mexican collection made by the indefatigable Mr. Charles Wright, in the year 1849. In the same or the preceding year, it was likewise collected by the late Dr. J. Gregg, in the Northern part of Mexico. Fine specimens also were gathered by Mr. Wright on his second journey, while attached to the scientific corps of the Boundary Commission. In 1851, while under the command of Col. Graham, he collected it on the northern border of the Mexican state of Sonora; in 1852, while returning under the orders of Major Emory, he again met with it in the western part of Texas. I presume it has likewise been found by Dr. C. C. Parry, and Dr. J. M. Bigelow, during the survey of the Rio Grande from El Paso downwards; but I have seen no specimens from them. Specimens are in both of Mr. Wright's distributed collections. I have, moreover, just detected it in the late Dr. Coulter's Mexican collection, whose name, as being the first discoverer, the species may appropriately bear. The natural order to which the plant in question belongs is not very evident at first view. In Mr. Wright's notes, made at the time of gathering it, the plant is mentioned as a doubtful *Borraginacea;*—a view suggested by the deeply four-lobed fruit, and the nearly regular, pentamerous calyx and corolla. But the leaves

are opposite, and the stamens are only four in number. The latter characters, along with the quadrinuculate fruit, and the axillary cymulose inflorescence, would incline us to refer the plant to the order *Labiatæ;* which again is forbidden by the regular corolla, the apparently equal stamens, and the amphitropous descending ovule. The latter character points to the true affinity of the genus, which unquestionably should be placed in the Viticeous division of the order *Verbenaceæ;* notwithstanding the deeply four-lobed ovary, and the fruit of four nucules. This remarkable character may well furnish the name of the genus;—which I accordingly form of τέτρα, four, and κλειω, to close or shut up, referring ro the four closed nutlets of the fruit.

TETRACLEA, Nov. Gen.

Calyx profunde quinquefidus, tubo turbinato, lobis subæqualibus. Corolla hypocraterimorpha, tubo calyce longiore, limbo quinquepartito, lobis obovatis fere æqualibus. Stamina 4, fauci corollæ inserta: filamenta filiformia, æquilonga, exserta, in alabastro involuta: antheræ ovales, loculis parallelis. Ovarium profunde quadrilobum: stylus filiformis apice bifidus: stigmata subulata. Ovula in loculis solitaria, amphitropa, pendula; micropyle infera. Fructus quadrinuculatus, calyce persistente immutato cinctus: nuculis siccis obovatis reticulatis crustaceis. Semen loculo conforme, subcurvatum, supra medium appensum, exalbuminosum. Embryo leviter incurvum; cotyledonibus ovalibus crassiusculis; radicula brevi infera.—Herba erecta, humilis, e basi suffrutescente; foliis oppositis petiolatis ovatis subdentatis; floribus in axillis cymulosis sæpius ternis majusculis; corolla alba post anthesin flavescente.

Tetraclea Coulteri.—Mexico, *Dr. Coulter* (No. 1172, in coll.).—Prairies of San Felipe and Live Oak Creeks, Texas, *Wright*, 1849 (No. 462); also at Escondido Springs, in the same district, 1852. Azufrora, near Saltillo, Mexico, *Dr. Gregg* (No. 502). Saur de Cieñega, between Conde's Camp and the Chiricahui Mountains, on the borders of New Mexico and Sonora, *Wright*, 1851 (No. 1513).

The other Verbenaceous plants of Mr. Wright's collection which appear to be new are *Bouchea linifolia*, sp. nov. (No. 449 and 1509), and *Lippia* (*Aloysia*) *Wrightii* (No. 1506)), a species allied to L. scorodonioides.

SCIENTIFIC INTELLIGENCE.

I. CORRESPONDENCE.

Correspondence of M. J. Nicklès, dated March, 1853.—*Continued.*

THOSE who have experimented on electric light have remarked the fact, that the current is not established until the two points of charcoal have been brought in contact. It may be made to pass, however, by sending an electric spark from a Leyden jar between the charcoal points, an experiment attributed by Sturgeon to Herschell (Annals of Electr., viii, 507). In both cases evidently the current is produced by causing a passage from one pole to the other of material particles.

M. Masson inferred from his early researches that the electricity of induction will not traverse the barometric vacuum, and that the presence of ponderable matter is necessary to its propagation. But on the other side, M. Quet and M. Despretz establish in different ways by precise experiments that the vacuum is not only a conductor of currents of induction, but also gives free passage to the direct current of the pile. M. Masson has since renewed his researches and has recognized the fact, that the vacuum is a conductor of induced electricity. And to this, he adds another, that two currents of induction may traverse the same wire going in opposite directions without mutual interference.

M. Quet experimented with Ruhmkorff's apparatus.* By interposing a galvanometer he observed that there was no deviation as long as the vacuum was not sufficiently advanced; but as soon as the successive discharges produced an appearance of continued light, the needle of the galvanometer deviated and afforded evidence of an electric current. The deviation increased as the rarefaction was made more perfect, and also as the balls terminating the poles were approached. This observation was made with the aid of the receiver called the *electric egg*. The very long spark thus produced in the vacuum, consisted of two kinds of light quite different in color, form, and position; one of a violet color surrounded the negative ball; the other, of a fiery red adhered to one side of the positive ball, and extended from the other to the negative ball, having for its limits laterally a surface of revolution around the axis of the receiver.

M. Quet has found that this double light is made up of a series of brilliant layers entirely separated from one another by dark layers, presenting thus a species of stratification. The structure was further shown by producing the vacuum in an atmosphere of the vapors either of wood spirit, essence of turpentine, alcohol, oil of naphtha, sulphuret of carbon, bichlorid of tin, fluorid of silicium, etc.; numerous brilliant layers were thus formed separated by dark layers, forming as it were a pile of electric light between the two poles of the receiver.

The nature of the vacuum influences more or less the colors of the two lights in this phenomenon of stratification. When the vacuum is made over fluorid of silicium, the negative light is yellow; when over essence of turpentine in glass tubes, the positive pole is covered with

* This Journal, [2] xv, 114.

long columns of fine white light and phosphorescent, in which the layers of the stratification are sensibly plane and of unequal thickness. In most of the vacuums the two lights are separated by a dark layer. On approximating to one another, the two balls, when the vacuum has been made in atmospheric air, the red light disappears completely whilst the violet brightens. In the vacuum made over the fluorid of silicium, the contrary is true; the light of the positive pole disappears, and the negative yellow light becomes very brilliant, as well as the purple rings which surround it. These rings are developed on the contrary about the positive pole when the two balls are much approximated.

These singular phenomena observed by MM. Ruhmkorff and Quet by using an interrupted current from a single Bunsen element with Ruhmkorff's apparatus, have also been observed by M. Despretz in the luminous arc produced by a continued current from an energetic battery; it is true, however, that M. Despretz has not analyzed the phenomenon as minutely as the two physicists before mentioned. M. Despretz has observed that in a vacuum nearly perfect, the spark of the pile may increase in brilliancy, and the arc may be formed and maintained at a distance of one and even five centimeters, not only with charcoal points but even with the metals. The distance at which the spark appears increases with the number of the elements.

Glycerine.—Glycerine is one of those substances produced abundantly in soap and candle making which was for a long time wasted, it being of no known utility. A method was patented some time since for protecting with it the zinc of a galvanic circuit, so as to do away with the necessity of amalgamation; but I have repeated the experiments with care without success, and other chemists have not been more fortunate with it.

A use of it of real importance has been more recently introduced. It is known that the clay for foundries dries rapidly, and requires hence a series of precautions on the part of the moulder, which are not always successful. To avoid these embarrassments, M. Barreswill kneads the clay with a concentrated solution of glycerine; and thus prepared, it retains its moisture and consistence as required.

These facts are called to mind by the appearance of a memoir of a purely theoretical character which M. Balard has presented to the Academy of Sciences in the name of its author, M. Berthelot, his assistant at the "College de France." As scientific labors usually precede the applications, we cannot multiply too much such researches as those of M. Berthelot or those which have been for some time ocoupying M. Redtenbacher.

M. Berthelot has generalized the important fact brought out by MM. Pelouze and Gelis—that is, that glycerine will combine with butyric acid and form *butyrine*, the proximate principle of butter. He has prepared *acetine*, which is probably the proximate principle of cod-liver oil; *valerine* which M. Chevreul extracted from whale oil and called phocenine; also *benzoicine* and *sebine*, which are examples of neutral compounds with a bibasic acid, the *sebacic*, and glycerine; and finally, M. Berthelot is in the way of preparing directly *stearine* and *margarine*.

This process is in general that of Pelouze and Gélis. The dry acid is put with the syrupy glycerine and heated to 100° C.; then a current of chlorohydric acid is passed for some hours, keeping the mixture at 100° C., and allowing it to cool in the current of gas. This done, the whole is left at the ordinary temperature, and the chlorohydric acid is applied again, as may be needed. After more or less time the combination is produced; and to isolate it, it is only necessary to saturate the mixture with carbonate of soda.

Quinidine.—As supplemental to our former article on Quinidine, we will say that M. Pasteur has explained the contradictions of the different results that have been published respecting this alcaloid. Quinidine is a mixture of two distinct alcaloids, differing in crystallization, solubility and rotatory powers; one is anhydrous, the other hydrous. The alcaloid which more resembles quinine, is optically the reverse of that base, it causing polarized light to deviate to the right.

Racemic acid.—M. Pasteur has presented through M. Biot, a notice of the source of racemic acid. We have reported in the January No. of this Journal some of the curious observations which M. Pasteur has made with this acid. It was in consequence of those observations that by the suggestion of M. Biot, the Academy requested this chemist to continue his researches at their expense. There has been a prompt reply, and we now know from M. Kestner and M. Pasteur, that racemic acid is a natural product, occurring in almost all the tartars; it is not an accidental result in manufacture, as believed by some chemists, or a product peculiar to the grapes of the Vosges, a supposition that arose from the position of M. Kestner's establishment, and which originated the name *vosgic* acid, changed to *thannic acid* by Gay-Lussac from Thann, a manufacturing village of the Upper Rhine, where are M. Kestner's works, in which this acid was discovered.

The process for racemic acid having been considered a secret of M. Kestner's, he was enquired of by M. Pelouze with regard to it, when this celebrated manufacturer mentioned the process he followed in 1820 when the discovery was made, and added that he had not been able since to obtain it. Hearing that an English manufacturer, Mr. White, had obtained racemic acid from the crude tartar of Naples, Sicily and Oporto, M. Kestner remembered that towards 1820 he had received part of his crude tartar from Italy. He had intended to take up the subject systematically; but being first kept at Paris as representative of the people, and soon afterwards exiled for the crime of republicanism, he was compelled to suspend his useful labors.

In this state of the subject, the Society of Pharmacy of Paris in 1851 proposed the two questions: Do these crude tartars contain racemic acid ready formed? Under what circumstances is tartaric acid transformed into racemic?

Soon after, M. Pereira reported that racemic acid was common in English commerce. But this was an exaggeration; the only vender in London, Mr. Simpson, received it from Germany. M. Pasteur hearing through M. Mitscherlich that it was made at a Saxon manufactory, visited the place but found little of the acid; the tartar had been received from Trieste. He was more successful at Vienna, where, guided by Prof. Redtenbacher, he detected it in the crude tartars of Austrian commerce. Those of Naples, Hungary and Styria also contained it.

After these developments by M. Pasteur, M. Kestner, with whom expense was nothing in this question, imported some crude tartar from Tuscany, and immediately obtained from it racemic acid; at the same time, M. Seybel at Vienna obtained considerable proportions of racemic acid.

To extract the acid from tartars which contain it, it is only requisite to operate on the mother liquor which has been a long time in use and to treat the residues as crude tartars.

M. Pasteur finds that the racemic acid from all the manufactories occurs in needles implanted on large crystals of tartaric acid; and at Vienna they were so abundant as to depreciate the value of the latter acid in commerce, which was considered impure.

M. Pasteur considers the transformation of tartaric acid into racemic as utopian. More ample details will be found in the Comptes Rendus of the Academy of the 3d of January, 1853.

Metacetic acid.—At a subsequent session of the Academy, attention was directed to a congener of racemic acid—the citric acid, for which M. Pasteur had done what I had myself proposed to do in 1846 and which I had moreover executed as regards tartaric acid.*

M. Noellner on examining a volatile acid accidentally produced in a manufacture of tartaric acid under his direction at Freudenstadt (Wurtemberg), thought he recognized a peculiar acid which Berzelius pronounced to be only a mixture of butyric and acetic acids. In 1846 Liebig sent me two specimens of this acid: one I found to be a mixture of acetic and butyric acids, the other contained a peculiar acid which was volatile at 140° C., produced a barytic salt crystallizing in oblique rhomboidal prisms, and which had a composition corresponding to the formula $C^6H^6O^4$, the formula of metacetic acid. M. Dumas on comparing my acid, which I called the *butyro-acetic*, with the metacetic, which he had just obtained by means of cyanhydric ether (Comptes Rendus, 1847), thought he had established their identity. In my view this identity was not proved. It is probably a case of isomerism like that of propylammine and triethylammine.

Whatever the fact, this acid was produced by M. Noellner at the expense of tartaric acid, while this chemist was drying a large quantity of tartrate of lime, an accident known to the manufacturers. It is then a product of fermentation, like that of butyric acid from lactic acid through the lactate of lime, of succinic acid through malate of lime. Time does not permit me now to operate upon the congeners of tartaric acid, and M. Personne has undertaken it,—a work important to the manufacturers of citric acid, who have been aware for a long time of the difficulty of preserving citrate of lime without alteration. On causing a large quantity of crude citrate of lime to ferment, M. Personne obtained acetic, butyric, and carbonic acids, and hydrogen. He considers the following as the reactions—

$$4(C^{12}H^3O^{11}+4HO)=3(C^4H^4O^4)+2(C^8H^8O^4)+20CO^2+8H,$$

and he thinks that the constant presence of hydrogen indicates the formation of lactic acid, and that this is the source of the butyric acid which is produced during this fermentation.

* Sur un acide particulier, resultant du tartre brut sous l'influence de la chaux et des ferments, par M. J. Nicklès, Revue Scient., Dec., 1846.

Correspondence of M. Jerome Nicklès, dated April 27, 1853.

Auguste Laurent.—The sad event for some time anticipated, has taken place. On the 15th of last April at half-past 8 o'clock, science lost one of her most illustrious representatives in the person of Auguste Laurent. His short life so well employed, was spent in his family and his laboratory. It was a life of contest with circumstances, and hence instructive to the moralist and philosopher; it was also, I fear not to say it, one of encouragement to the earnest worker who puts principles before persons and prefers the straight path to intrigue. If ever a man elevated himself by the force of genius and perseverance, such preëminently was Laurent, to whom everything was denied, and who made his chef-d'œuvre out of nothing. Laurent was one of those men who must die before they can be fully appreciated; I well know that he will receive his due only when impartial history shall be substituted for self-love and party spirit. It will then be acknowledged that during the short space of time in which he appeared above the scientific horizon, the ideas that he brought forward were successively confirmed, after the announcement of his fundamental principle which he thus expresses:—that *Form or arrangement has often more influence on properties than matter itself*—a principle which served as the guiding thread in his researches, even to the theories of *substitution*, of *hemimorphism*, of *isomeromorphism*, and of *crystalline types*, these in fact being corallaries from this principle.

Few chemists have understood Laurent; and if we except Mr. T. S. Hunt of Montreal, Messrs. Williamson and Hofmann of London, M. Strecker, MM. Gerhardt, Chancel, Bessaignes and some others, and finally the learned and venerable Leopold Gmelin of Heidelberg, the rest generally end with admiring the fertility of this extraordinary man and the great number of new compounds which, with means the most simple, he has discovered, isolated, studied and analyzed.

I do not pretend to write his biography. I feel neither worthy nor capable, and find myself too much under the influence of grief to trace out coldly biographical details. But what I may affirm, after having attended upon his last moments, is that his death was worthy of a life so pure; not a word of blame for those who had wronged him, but expressions of deep regret at his unfinished work and his limited means for executing his labors. His love of science came out in his delirium, and in his hallucinations he believed himself in his laboratory.

Foreseeing his death as near, his friends, with different pretexts, urged that he should give an exposition of his views, such a one in fact as was asked of him by M. Liebig nine years before, when Laurent, while at Giessen, gave by request of the chemists of the laboratory, an extempore discourse on his theories in the lecture-room of the school. Liebig offered him at that time an entire number of his Annalen for the publication of a review of his labors and of the ideas which had guided him in his researches; and three of the students offered also to translate the work into German, English and Italian. This project is now in part to be realized; the manuscript, which I have in my hands will soon be put to press, and I believe that I may announce to the scientific public that before six weeks from this—now the 20th

of April, this last work of M. Laurent will be printed and published,—even with its imperfections, for no changes will be allowed; even the punctuation throughout will be respected, although he considered it susceptible of modification and proposed to undertake it.

Laurent was elected a corresponding member of the Academy of Sciences in place of M. Faraday, who had become Foreign Associate; time was not allowed him to be made a privileged member: he died nearly at the age of Scheele and Lavoisier, at 46 years.

In 1828 Laurent was student in the Ecole des Mines, and he there made his first essays in science, by his researches on the treatment of ores of cobalt, arsenic, &c., and his experiments on the fabrication of smalt, etc. Being then named to the modest place of chemist to the manufactory of porcelain at Sèvres, at that time directed by Alex. Brongniart, he made his researches on the cementation of steel; he demonstrated (1837) the volatility of carbon at high temperatures; he studied the products of distillation of the oils of bituminous schist; he proposed the use of paraffine and of different carbo-hydrogens of this oil for lighting; and he finally threw himself into organic chemistry, which he pursued in a manner the most brilliant while with means so narrow.

Too generous, too disinterested to be capable of drawing any pecuniary benefit from his discoveries, he cast them into the public domain, wherever occasions presented, and thus gave fortunes to others. It was only after the revolution of February that justice commenced to favor him. In a country where all is done by the government, it was the part of a republican government to occupy itself with the welfare of one of its most illustrious citizens. On the 14th of May, 1848, Laurent was named assayer at the Mint. This was the commencement of reparation. The Republic did not continue, so as to make the reparation complete, and Laurent died without having realized his favorite idea of having at his disposal one of the numerous laboratories of Paris where he might work without keeping an account with his purse.

Auguste Laurent leaves a widow and two young children, and friends who deplore him with much tenderness: to the former he bequeathed the glory of his illustrious reputation, to the latter, his example; to all a model of self-denial, of devotedness, and of sacrifices.

Repeopling of Streams with fishes, or Pisciculture.—In my last communication I mentioned briefly the experiments of M. Millet on the reproduction of fishes. I have said that, thanks to the modest fisherman of the Vosges, Rémy, fish is now in fact a manufacture in France,—a fact most valuable to our old Europe, which has hardly the means of sustaining its inhabitants, and whose streams have been depopulated of the good kinds of fish, the spawn having been destroyed by manufactories along the water courses, by steamboats, drainage-works and inundations.

A paper by M. Haxo, secretary to the Société d'Emulation des Vosges, gives the history of this important invention, and reviews the means employed by Rémy for populating with trout the streams of his neighborhood. This fisherman observed the time when the female deposited its eggs; he remarked that the male then comes and spreads over it the fecundating liquid; and as our observer could but imperfectly

protect these eggs from the various chances of destruction, he learned how to imitate nature, by promoting the parturition of the female, and then that of the male, and placing the eggs in the conditions most favorable for their development; he had thus the happiness of seeing the breeding of a certain number of trout, and noticed their preserving under the venter a part of their eggs, and living during some time at the expense of the rest.

But this was not all: it was necessary to provide for the ulterior preservation of the young animal by a practicable process. The obscure fisherman, who hardly knew how to read, did not yield before this difficulty: he set at work observing again; he placed some frogs in the basin containing the young trout, judging with reason that the spawn of these batrachians would be a resource for the spawn of the trout; he gave them also bits of veal as they grew larger. But as these aliments, though suucessful, would be too expensive, Rémy, not knowing of the existence of the sciences of botany and chemistry, contrived a process based on one of the great laws of nature. He planted some herbivorous fishes in the water which contained the carnivorous trouts, and from this moment he had no more trouble with the raising of his "élèves." In the course of six years, with very limited means, Rémy, who was in the interval associated with Géhin, had bred several millions of salmon and trout. After he had been for six years thus preparing the living food for his fishes, M. Haxo, made known his results to the Academy of Sciences, and the government ordered a full investigation into Rémy's process. Pisciculture was established in the basins of the canal of the Rhone, on the Rhine at Luningue, in the department of the Upper Rhine, not under the direction of Rémy or of Géhin, but of M. Coste, who had succeeded in appropriating to his own profit the labors of the modest fisherman. A spirited dispute ensued, which continues still, and has engaged several independent pens, as MM. Haxo, Victor Meunier, the journal "La Presse," the Abbé Moigno, etc., who defended the rights of the oppressed against the despoiler. Justice will be done; Rémy will receive a pension as a national recompense.

I pass in silence the reclamations of priority, and the attacks of all kinds which have accompanied the success of Rémy. My last communication on hot air engines, has shewn how such facts are rapidly produced whenever there is success.

The following is briefly the method employed in this new branch of industry. Through M. Millet, Inspector of forests, the processes are become so simple that they can be executed by the most inexperienced hands. The Administration of the waters and forests, is now organizing a regular service for effecting a repeopling of the waters of navigable streams. The apparatus of M. Millet is placed in the hands of the fish-keepers, and the living alimentary material will be manufactured so to speak, at all points. The details which follow are taken from a work yet unpublished on Millet's process, which I have seen in the course of its preparation.

Two boxes of lead, 1 meter long and 1 to 2 decimeters broad, and 5 to 6 centimeters deep, are disposed in steps in the fire-place of his apartments. Some frames or sieves of hair, flags or metallic network,

etc., contain the eggs. According to the species, these eggs are immersed to a depth of one or several centimeters. These frames may be withdrawn or replaced at will, by means of tringles which support them by pressing against the side of the box. A reservoir of water, furnished with charcoal and gravel is near by and turns into the box, drop by drop, filtered water, furnishing about 2 or 3 litres of water per hour. The water is thus always in motion, and it is only necessary to fill the reservoir each morning to keep the apparatus in action without supervision.

The total expense of the establishment is but 6 francs. With 35 litres of water for six weeks, M. Millet has bred about 25000 trout or salmon, and he expects to breed some millions of different species in the course of the year.

In order to obtain the eggs from the female, M. Millet employs nearly the process used by Rémy and Géhin. He makes the eggs to pass out only as they are mature, leaving an interval of two days between each operation, this consisting in passing the finger lightly over the surface of the abdomen of the female. Another process consists in enclosing the female in a cage with a double bottom, formed of bars rather far apart; the females drop their eggs by organic contraction, and aid themselves in it by rubbing against the bars. The eggs fall upon the frame. The males are then introduced, and often they fecundate at once the eggs, being incited to it by the presence of the female and the odor of the eggs; but if not so, it is provoked by slight friction as in the ejection of the eggs from the female.

Another result of interest is that M. Millet has caused trout and like species which live in running streams, to breed in standing waters, by causing some aquatic plants to grow in the water. The species which I have seen employed, was the *Lemna minor* (duck weed).

This experiment calls to mind the *organic equilibrium* of Mr. Warrington. It is known that this chemist has for several years kept in a glass vase full of water, a small aquatic menagerie, consisting of a *Valisneria spiralis*, several fish (species of Gasterosteus), and some aquatic univalves, without injuring the purity of the water. It is seen that the carbonic acid and azotized products given out by the animals are absorbed by the plant, which converts at the same time the carbonic acid into oxygen. The debris of the plant serves as nutriment to the snails whose eggs in their turn feed the fish.

The process of M. Millet has been put in practice in several places near Paris, and repeopling the rivers has been already begun. Contrary to the prescription of Rémy and Géhin, who nourished the young for some time on the spawn of frogs and coagulated blood, after the pouch under the venter had disappeared, M. Millet commences the distribution of them whenever this period has arrived. The future will show whether the method just mentioned is wise, or whether it will not be necessary to return to the process of Rémy, which consists in "sowing" herbivorous fishes in the streams populated by the trouts. M. Millet is still engaged in his labors, and we shall endeavor to keep our readers acquainted with the progress of this new branch of industry.

On the destruction of insects by gaseous injections.—On the same occasion with the reading of the preceding memoir, another relating to ap-

plied zoology, was communicated to the Academy by M. Quatrefages. This naturalist has also acted an important part in the history of pisciculture, for it was in consequence of his memoir published in 1847, on the possibility of repeopling the water-courses by artificial fecundations, that the Academy took a favorable notice of the letter in which M. Haxo reported on Rémy's processes in the Vosges. In the present memoir he aims at destroying an animal well known for its ravages—the Termites (Termes lucifugum, *R.*). This Neuroptera has been especially destructive about the villages of Saintes, Tonnay-Charente, and Rochefort. Roofs and floors are often completely riddled in these villages by these animals so feeble in appearance; and even entire houses have been so destroyed in their foundations, that they had to be abandoned or rebuilt. The danger from these depredators is the greater, that they work altogether out of sight, and respect with extreme care the surface of the bodies they attack. The Archives of Rochelle for certain years have been completely devoured by the termites, (excepting the outer surface which gives no evidence of the destruction within,) and of recent years they have been enclosed in zinc. At La Rochelle the invasion has even extended to the Arsenal and the Prefecture, and the whole village is threatened.

M. de Quatrefages has made some experiments, which solves the problem of their destruction. He has shown that the gases which are most energetic are chlorine and nitrous vapor NO_4; sulphurous acid is less active, and oxyd of nitrogen, NO_2, acts only when it can be transformed into hyponitric acid, under the influence of a little oxygen. These gases have been made to act on fragments of wood infested with the termites, and have so penetrated into the deeper termitic cellules, that none have escaped.

As the application of gas in many cases must be inconvenient, it is recommended to prepare the wood before employing it in construction. The method hitherto employed for preserving woods, have had reference rather to protection against decay than insects. There is an exception in the proces of Bethell, which consists in saturating the wood with a bituminous oil rich in naphthaline, a material proceeding from the distillation of the bitumen of coal. The cross-timbers of the Stockton and Barlington Railway, prepared in this way, ten years since, are still untouched; and the same is true of the timbers of part of the London and Northwestern Railway. At the port of Lowestoft, the naphthalized piles are wholly exempt from the attacks of insects, while wood unprepared is more or less deeply eaten. The disastrous results mentioned by M. de Quatrefages, will not fail to call attention to this process which has been sometimes objected to on account of its making the wood more combustible.

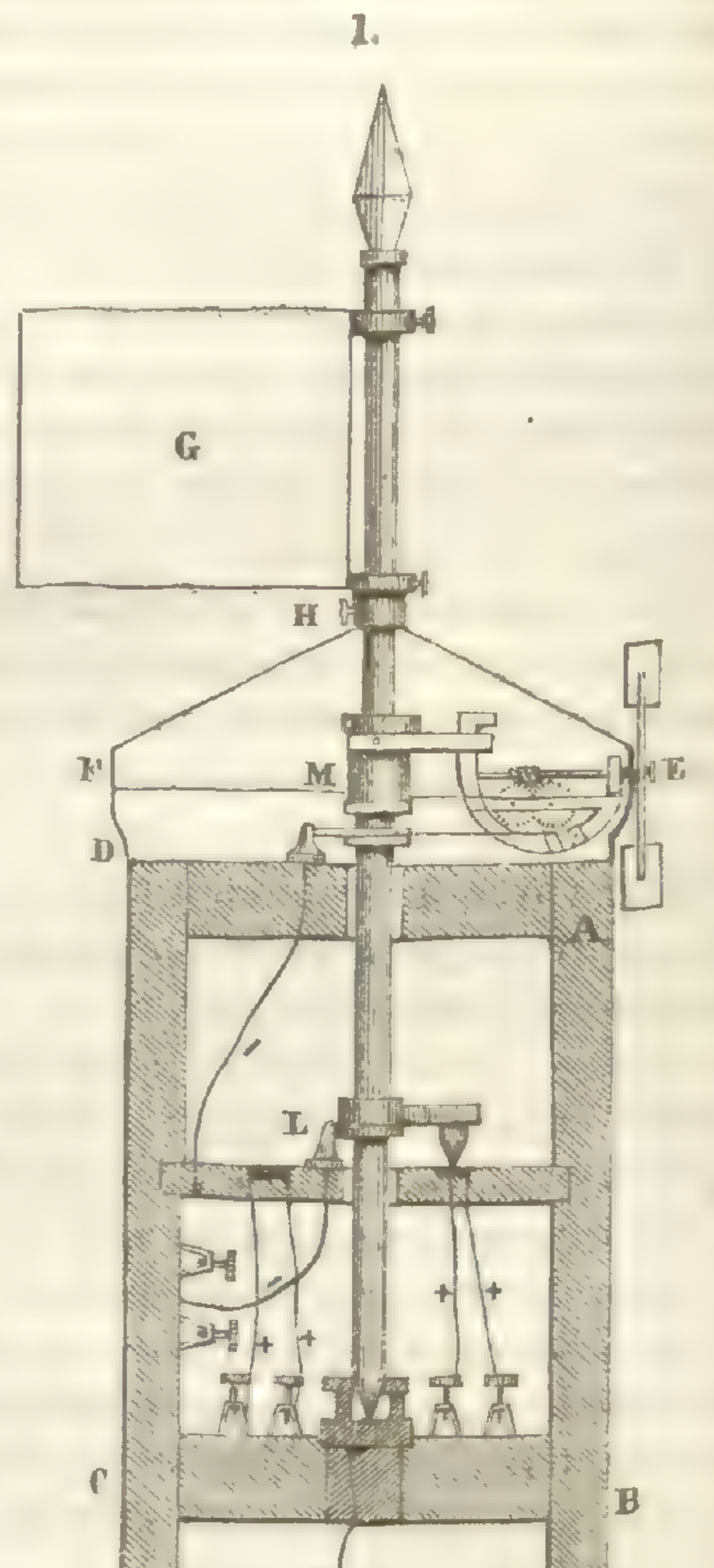
Electro-magnetic Anemometer.—For some time past, the merits of a new electro-magnetic anemometer have been under discussion among the savants of Paris, which, by a recent improvement, has reached a sensibility that enables it to mark the direction, velocity, continuance, and succession of changes in the winds; and moreover, the apparatus gives monthly recapitulations of the observations such as are needed for calculating the means of the months, and relieves the observer consequently of the trouble of reviewing, counting and measuring the marks

drawn by the registering crayons. As M. Arago is about to give to this instrument the honors of the observatory, we will enter into some details in its description.

Figures 1 and 2 are drawn from the apparatus such as it was when its author, M. Dumoncel, presented it to the Academy of Sciences. It consists of two distinct parts: 1, of the Anemometer properly called, which is placed on a roof, tower, or it may be on a mountain, and which receives the different influences of the winds; 2, a Registering apparatus, which registers all these influences, and which is kept in the room of the observer.

1. *The Anemometer properly so-called.*—It consists of a cylindrical box ABCD, (fig. 1,) at the center of which turns a weathercock or vane G, on a moveable axis, which carries a Woltmann's windmill ("moulinet") ME, and a bent lever L to act on a commutator. The box ABCD is covered with zinc; it is bounded by an elevated border AE, DF, above which a roof "en parasol" FHE is soldered to the axis of the vane. The windmill ME, can thus turn freely with the weathercock and is secure from the rains.

1.



The commutator connected with the lever L, consists of a plain metallic circle, divided into eight sectors isolated from one another by threads of ivory. Each of these sectors is in connection with a metallic wire passing from the index apparatus, and going to one of the poles of the battery. The other pole has a metallic communication with the lever L. In order to insure the contact of this lever with the conductor which supplies the current, M. Dumoncel employs two metallic springs pressing constantly on the lever L.

From this arrangement, it is seen that if the eight sectors of the flat metallic crown are so arranged as to correspond to the 8 principal winds, and the lever L is made to act constantly on the metallic crown, it follows that the current will be established in one or the other of the 8 wires, according to the direction of the vane. The changes of direction in the wind will hence be indicated by the continuance or the rupture of the current in the 8 wires which correspond to its different directions.

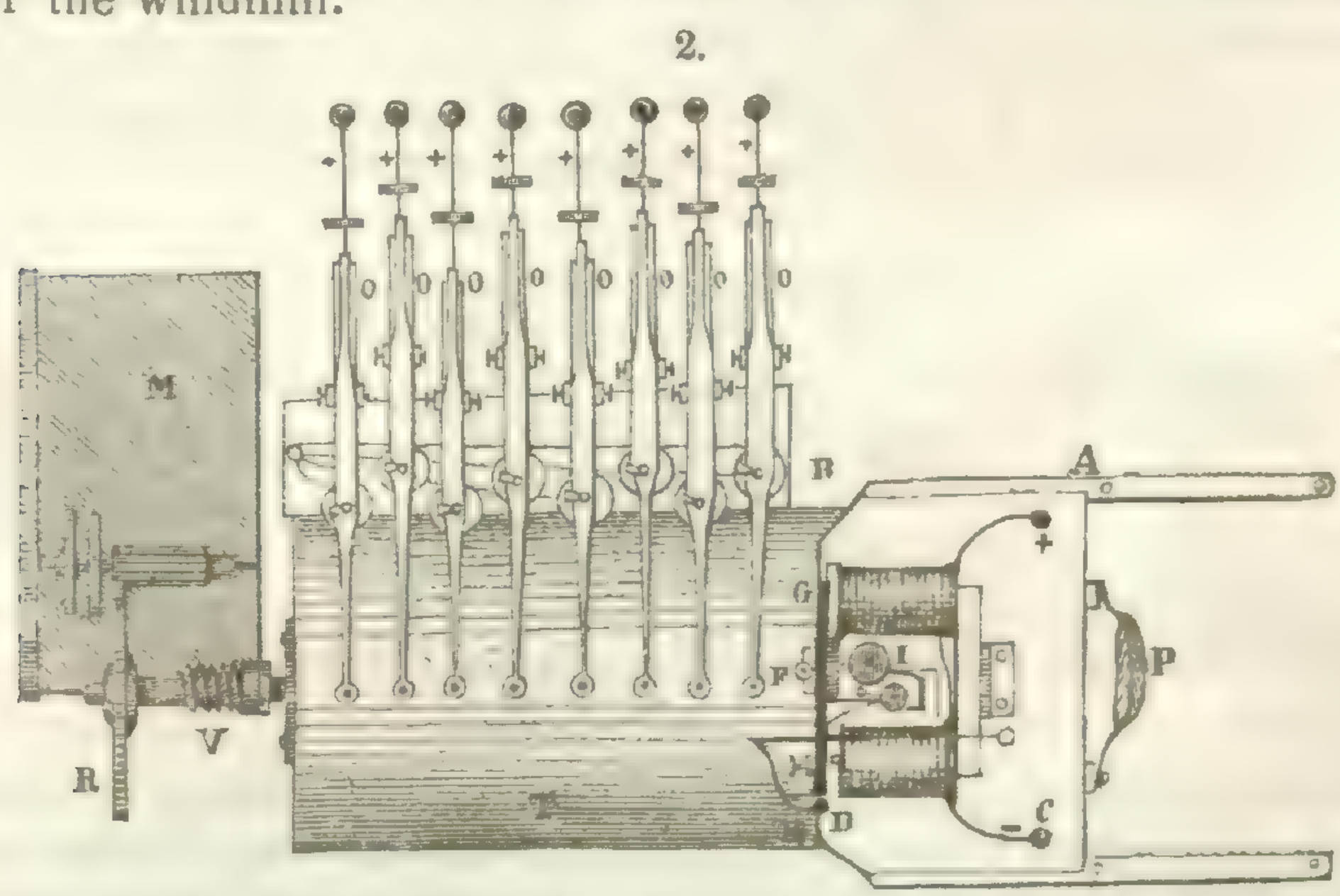
We may now consider how the *velocity* of the wind furnishes indications. The windmill of Woltmann consists, as is known, of four wings, which turn the more rapidly the stronger the wind; and the degree of

rapidity is measured by a register or counter on which it acts; an endless screw fixed upon the axis of the windmill works into a system of cog-wheels, so combined, that when the last makes one turn, the windmiil makes 500. The apparatus being fixed on the axis of the vane and perpendicularly to the direction of the wind, let us suppose that one of the conductors is connected with it, and that the other conductor ends at a small metallic spring fixed within reach of the last wheel of the counter, being isolated from the apparatus by plates of ivory. If then, at the zero point of this wheel of the counter, a small metallic button is soldered, the spring, on touching against this button, at each turn of the wheel, will close the current for each of the five hundred turns of the windmill. The current in connection with this part of the apparatus will then be closed at intervals more or less distant.

The current is transmitted to the windmill by means of the axis of the vane. The bent lever L is by a simple means isolated from the axis. The return current arrives at the spring of the counter, by a mode of transmission analogous to the preceding; two springs press upon a metallic ring which is fixed upon the axis of the vane over an intermediate plate of ivory: this ring may be put into communication with the spring of the counter; and the current may be closed or interrupted in the windmill independently of its motion with the vane.

2. *Registering Apparatus*, (fig. 2.)—For registering in the observers apartment the various changes, M. Dumoncel introduces into the circuit formed by each of the eight wires corresponding to the different winds, an electro-magnet whose armature is furnished with a crayon which falls whenever the current is established, and leaves its mark on a sheet of paper arranged for the purpose. These eight electro-magnets represent each a wind; they are placed parallel to one another. A ninth in a horizontal position corresponds to the circuit of the windmill.

2.



A cylinder T, serves to mark the time for the indications afforded by the electro-magnets; it is connected with a clock movement and revolves once in 12 hours It is covered with a sheet of paper, and the crayons of the vertical electro-magnets come in contact with it at a point whose height on the cylinder indicates the direction of the wind

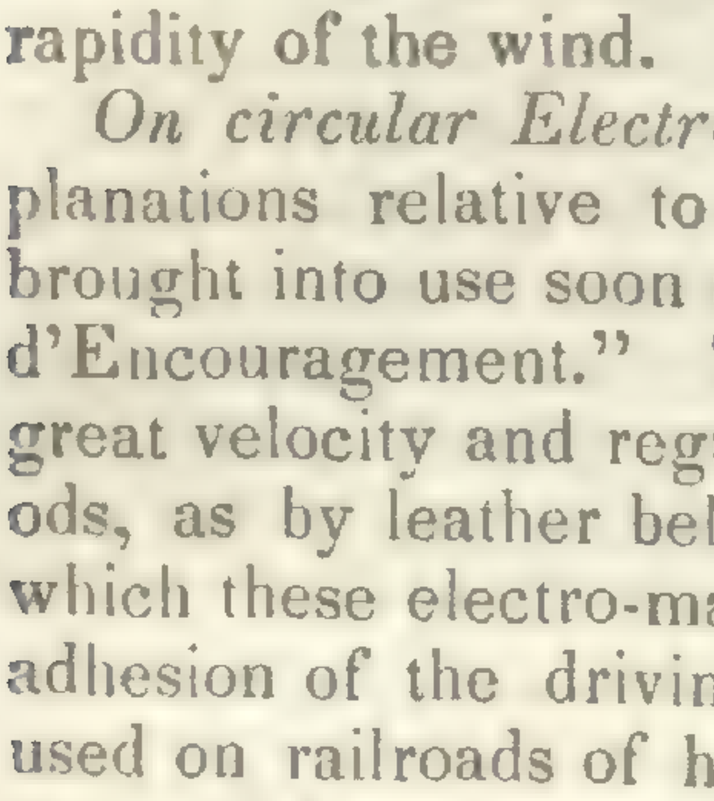
then blowing. While the wind is from a given direction, the same crayon rests upon the cylinder, and leaves a trace, the length of which shows how long it continued; and when the vane changes, another crayon falls, and so on. By measuring all these tracings, the duration of each wind for the 12 hours is ascertained.

To simplify the reduction of the observations marked on 30 sheets of paper by the 8 crayon points, M. Dumoncel unites to his registering apparatus, an axis revolving in 12 hours, and furnished with 8 electro-magnets forming a new system. These electro-magnets, of a circular form, as described below, are put in connection by means of armatures ("galets") of soft iron, with 8 counters corresponding each with one of the 8 helices which carry the crayons, so that the current passes at the same time in the helix and in the electro-magnet.

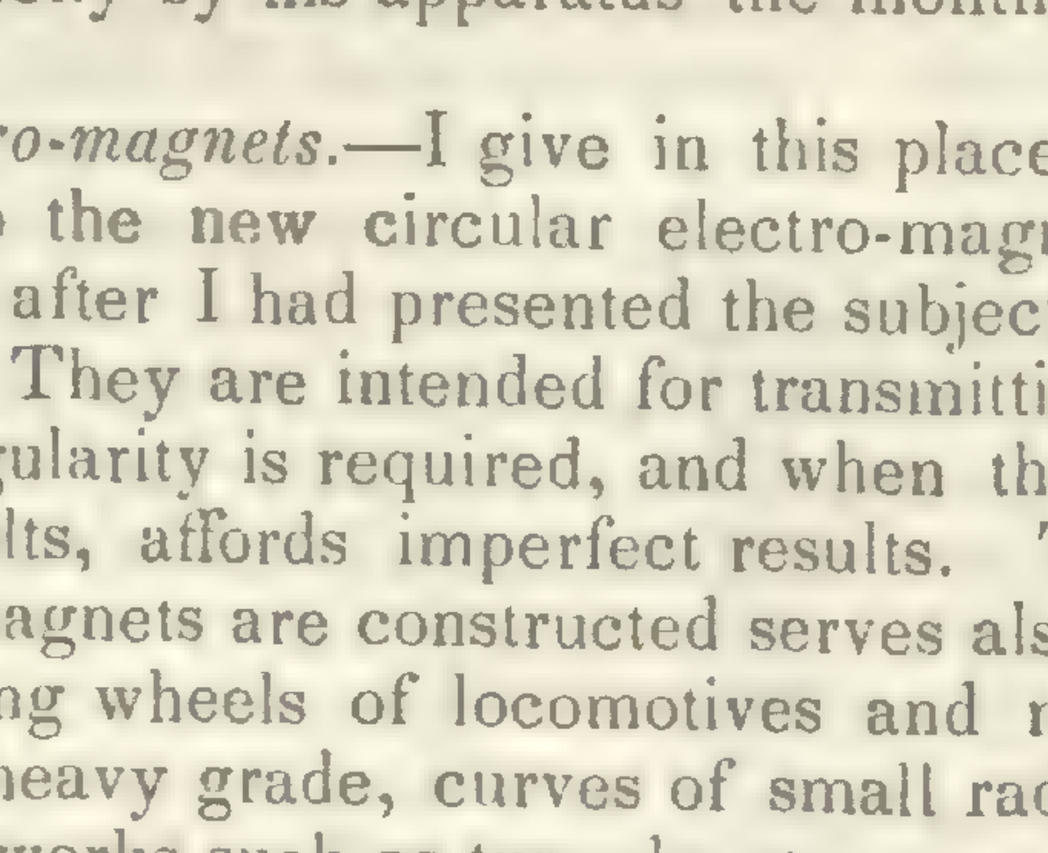
It is seen that whilst the axis which carries these electro-magnets turns by means of a clock movement, each electro-magnet is magnetized as often as the wind causes the crayon to act which is in communication with the helix of this electo-magnet. But each time that this electro-magnet is set in action, the soft iron armature which turns around with it also in the 12 hours, and which is kept raised by an opposing spring, falls, causing the lever of the counter to move, and adds a unit to the number marked by this counter. Finally, M. Dumoncel states that he is able to indicate directly by his apparatus the monthly means for the rapidity of the wind.

On circular Electro-magnets.—I give in this place some brief explanations relative to the new circular electro-magnets which were brought into use soon after I had presented the subject to the "Société d'Encouragement." They are intended for transmitting motion where great velocity and regularity is required, and when the ordinary methods, as by leather belts, affords imperfect results. The principle on which these electro-magnets are constructed serves also to increase the adhesion of the driving wheels of locomotives and may therefore be used on railroads of heavy grade, curves of small radius, and thus do away with numerous works such as tunnels, etc.

3.



4.



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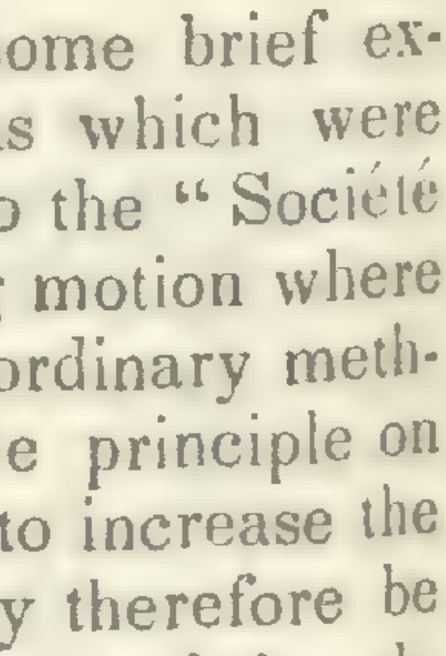

CIRCULAR ELECTRO-MAGNETS.

Figures 3, 4 and 5 represent these magnets. Conceive of a pulley of iron within which is lodged an insulated copper wire. This wire is wound on the middle of the pulley: it makes part of its mass, or better, it is independent and wound upon a spool of brass which surrounds the middle without touching it. In the former case, the helix communicates with the pile by the known methods; in the second, it is directly connected with the poles of the battery, for it is fixed and the iron pulley alone is moveable.

Let us consider for a moment figure 3. When the current is established, the electro-magnet is divided into two parts magnetically distinct, one boreal, n, and the other austral, n', and since the helix surrounds the middle of the pulley, it is evident that each of the circles is equally magnetized in each point of its circumference and that the magnetization is maintained thus during repose as well as motion.

Figure 4 represents a pulley with two channels, and consequently, with two helices, by means of which we may produce an electro-magnet "à point conséquent" if a contrary direction is given to the current, or if a normal electro-magnet having contrary poles at the extremities is used and the currents have the same direction.

This magnetic traction, operating as seen between turned pullies which are consequently without teeth, is attended with much less friction than where there are ordinary cog wheels; and the rapidity of the movement may be rendered as great as possible without being restricted to a certain relation between the diameter of the magnetized pulley and the armature pulley.

With a pulley like figure 4, 34 centimeters in diameter, I have obtained three horse-power of force with a velocity of 300 turns per minute. The sum of the thicknesses of the three circles was seven centimeters. In the next number, I will treat fully of this subject of circular electro-magnets, which has received in Dumoncel's anemometer only a limited application since great rapidity is not required.

On Inductive Electric machines and on a simple means of increasing their effects.—The inductive machine described by us in the January number of this Journal, invented by M. Ruhmkorff, greatly interests experimenters, and is leading to many new observations. It is however inconvenient if desired to be used as an ordinary electric machine, where there is need of an increase of tension. This is owing to the fact that at each induction, the inducing wire gives passage to an induced current which increases considerably the electric tension at the point where a spark is given out from the interruptor. This spark acts it is true on connections of platinum: but its energy is such that the surfaces are soon tarnished, fused and bored through; and the vibrations becoming thus less constant, the production of electricity ceases to be regular. An attentive study of this machine has led M. Fizeau to observe that the current of induction which is produced in the inducing wire at the moment of the rupture of the circuit, exerts a strong influence on the production of the electricity in the induced wire which terminates at the two poles of the machine. When this current is produced freely and becomes strong, the poles of the machine give little electricity; but if the current meets with obstacles and is only feeble, the poles have much electricity and the power of the machine is far greater. Several arrangements satisfactorily prove this, such as the use of metals, less liable to be acted upon than platinum, upon the surfaces of the interruptor, and uniting the vibrating parts by fine wires of different lengths.

The means of increasing the power of the machine is then to prevent the development of the current which is produced in the inducing wire at the moment of the rupture of the circuit, by acting directly on the tension of the current and rendering it more feeble. M. Fizeau

has succeeded in applying the principle of the Leyden jar to the electric charge by means of the current induced in the inducing wire.

For this end, this physicist arranges a condenser made of two plates of tin, juxtaposed and insulated by a bed of varnish, and puts each of these plates in communication with each extremity of the inducing wire. The points of attachment should be on both sides at the point of interruption where the sparks are produced. Then the two electricities before reaching the point of interruption, spread over the two surfaces of tin, where they lose a large part of their tension through the mutual influence across the insulating coats of varnish.

When the condenser has a surface of sufficient size, five or six square decimeters for example, it is seen, as soon as the communications are established, that the light is diminished at the point of interruption, and at the same time, the machine increases remarkably in energy. The poles then give stronger and longer sparks than before.

The condenser may be conveniently placed in a horizontal position, a little above the electro-magnet and upon four supports of glass. M. Sinsteden who has described his methods in Poggendorff's Annalen, also employs the condenser, but only for the induced wire, and his apparatus presents no great advantages.

The value of Fizeau's modification of Ruhmkorff's apparatus is shown by the following fact. A galvanometer being placed in the circuit, electricity was made to pass produced by the machine in rarefied air, when the beautiful phenomena of light were shown which are mentioned in my last communication.* When the machine operated in its ordinary condition, the needle of the galvanometer indicated a deviation of 8°; but with the condenser, the light produced had a much greater brilliancy, and the deviation of the needle amounted to 15°, showing that the intensity of the current was nearly doubled. The machine with Fizeau's addition is hence rendered more powerful, and will act for a longer time in a constant manner. The arrangement may hence be advantageously used in the construction of new apparatus.

On certain chemical reactions important to health in populous cities.—Under this title, M. Chevreul has prepared a memoir in which he attempts to prove that the insalubrity of the soil of populous cities is owing to the organic matters which infilter into it and there remain. He examines the means by which the injurious influences may be diminished. The causes of salubrity are those which tend (1) *to distribute water in the soil to carry off the organic matters*, and (2) *to disseminate oxygen in it to consume these matters*; and consequently the causes which (1) *carry organic matters into the soil*, or (2) *absorb the oxygen before it has acted on these matters*, are sources of insalubrity.

Following out these views, M. Chevreul examines the influence of the paving of streets on the salubrity of the soil when considered as an obstacle to the penetration of rain waters; the influence of air; of solar light; of empyreumatic substances derived from conduits of gas: of the water running from public fountains; of sulphate of lime and of organic matters in producing an alkaline sulphuret, etc.

* This volume, page 99.

It would not be possible to mention here the important facts of this memoir; the results below are from a note which M. Chevreul has annexed to his paper. The whole will appear in the Memoirs of the Academy of Science.

This note relates to the examination of the black material found under the pavements of the streets of Paris and between the stones. It owes its origin to the iron rubbed off from the tires of carriage wheels and shoes of horses, and is carried into the pavement by the rains. In its fine state of division, the iron readily oxydizes under the agency of the air and moisture, becoming first magnetic oxyd and then peroxyd; and moreover, from the analysis of this material, it has been found that there is a large quantity of sulphuret of iron. The presence of such a bed in the soil, tends, according to M. Chevreul, to deprive of oxygen the air which penetrates it, and it should therefore be considered an obstacle to the salutary influence of the atmospheric oxygen.

M. Chevreul also mentions the following facts. Iron put in contact with plaster in a flask not hermetically sealed, at the end of seven years is changed into black magnetic oxyd with a little ammonia. If albumine is added to the mixture, a large quantity of chlorohydrate and sulphate of ammonia is produced with some magnetic oxyd and peroxyd of iron. Also by adding to the iron plaster and water, some gum arabic, a mixture of butyrate and acetate of peroxyd of iron is produced. In neither of these cases was a sulphuret formed.

On the reproduction of engravings and designs by means of the vapor of iodine.—Among the 2,000,000 of unproductive beings which are supported in Europe at public expense, to parade public places and amuse the idle, M. Niepce de St. Victor is an exception. Captain of the guards at Paris, he employs his leisure hours at the barracks in extending the domain of photography, and continues thus in the course which his uncle, Niepce, opened by the part which he took in the invention of the daguerreotype. Numerous discoveries have proceeded from his researches. He has just now completed a work, the first part of which appeared in 1847, treating of the effect of using different vapors, and especially that of iodine, in photography. He has shown that the vapor of iodine diffuses itself over the black lines in an engraving, to the exclusion of the white, and that we may reproduce the image on paper prepared with starch, or on glass covered with it, and thus form a design, the colored part of which will be iodid of starch. These designs are however not permanent. But M. Niepce has pursued the subject, and by the following method they are rendered unalterable.

If the design obtained as just mentioned is plunged into a solution of nitrate of silver, it disappears; but on exposing the paper or glass for some seconds to the light, the original design of iodid of starch is changed into iodid of silver; and by further exposure to the light, this iodid, being much more sensitive than the nitrate of silver contained in the paper or in the layer of starch on the glass, is acted upon before the nitrate; it is then only needed to plunge the glass or paper into a solution of gallic acid to bring out the original design, which is then treated with hyposulphite of soda, just as for photographic pictures. The pictures are thus rendered as permanent as ordinary photographs.

M. Bayard the skillful photographer, has just made another application of iodine. After exposing the engraving to the vapor of iodine, he applies it to glass prepared with sensitive albumen, in order to produce a negative proof, he then with this obtains positive proofs on paper by the known processes. He has thus made some most magnificent copies of very old engravings, without defacing in any way the originals.

On the application of fatty acids to illumination.—While science is in search of a more economical process than those now used for making fatty acids, we can do nothing better towards diminishing the cost, than to perfect the methods employed, and especially to so manage the saponification as to obtain a useful residue, and not a product of no value, such as sulphate of lime, which is formed by the decomposition of calcareous soap by sulphuric acid.

Under this idea, M. Cambacéres has modified this kind of manufacture, by combining the sulphuric acid with alumina, so as to obtain a residue of some commercial value.

Alumine does not saponify directly: but M. Cambacéres overcomes this difficulty, by availing himself of the property, which some alkaline soaps have, of dissolving alumine. He uses clay, which is mainly alumine; and as the solution goes on, the alkali separates from the fatty body with which it was combined. The aluminous soap thus formed, is then precipitated by the aid of an excess of alkali, a large quantity of water, or a saline solution. The soap separates in a gelatinous mass, and its decomposition is effected without difficulty by means of the acid. The silica of the clay separates from the alumine when the saline solution is concentrated in order to obtain the salt in a solid state.

Different memoirs.—Among the various papers presented to the Academy, we mention the *researches on the composition of sweat*, by M. Favre. By operating on large quantities of this secretion, M. Favre has detected a new acid, having the constitution of *creatine*, *sarcosine*, etc., which he calls *hydrotic acid*. The subject from whom he procured the material for examination was a philanthropic physician, Dr. Tecker, who voluntarily exposed himself to a high temperature, and thus furnished M. Favre 40 litres of sweat.

Researches on the presence of boracic acid in mineral waters.—MM. Baup, Bouis, Filhol, Béchamp of Strasburg have in turn recognized boracic acid in the mineral waters of different provinces, by using Rose's test, which depends on the red color produced by boracic acid on turmeric paper in the presence of chlorohydric acid.—In a memoir by M. L. de Munster, (Upper Rhine,) *on cubic alum*, the author shows that cubic and ordinary alum are identical; and that the cubic form is a result analogous to many facts long since explained by Beudant.

On Phycite, by M. Lamy, (of Lille).—Phycite is a saccharine substance obtained from an Alga, the Protococcus vulgaris, known under the name "Phycic." It does not ferment, nor act on polarized light; it is not altered by potash, and does not form definite compounds with bases. It contains one equivalent of hydrogen more than mannite.

$$C^{12}\ H^{15}\ O^{12}\ (\text{Phycite}) = C^{12}\ H^{14}\ O^{12}\ (\text{Mannite}) + H.$$

On the composition of the air confined in vegetable mould.—M. Boussingault, in this paper gives an account of numerous experiments

made by him, in connection with one of his students, M. Léwy. The researches were carried on during the last summer on the fine estate of Bechelbronn,—so celebrated in agronomic investigations, owing to the numerous works here executed by M. Boussingault. Situated in a region peculiarly agricultural, and one of the richest in France—the Lower Rhine—surrounded with vineyards and cultivated fields of other kinds, alongside of the mine which furnishes the asphaltum called *Lobsann*, and near by a deposit of rock salt, it has furnished this illustrious observer many occasions for utilising his varied knowledge. It was at Lobsann that he made the first attempts towards lighting mines by electric light.—*A report by M. Dumas on the anhydrous acids discovered by Gerhardt*, the conclusions in which are favorable to the views in the memoir, is a triumph for the ideas sustained by Laurent and with him by Gerhardt. Unfortunately, this triumph finds Laurent on his deathbed.—There are also important *researches on granite*, by M. A. Delesse; a report by M. Dufrénoy, *on the phenomena which accompany the crystallizations of sulphur and phosphorus*, by M. Brame; a memoir by M. Bérard, on the manufacture by heat of artificial blocks for hydraulic structures;—and many others in different branches of the physical sciences. One memoir which escapes classification, has for its title, *the divining rod applied to the search for subterranean waters and metals*, the author of which, an inhabitant of the Isles d'Hières, offers to make the journey to Paris to repeat before the Academy his experiments if they desire it.

A like activity has prevailed for the two months past in the "Société d'Encouragement," of which M. Dumas is President. Thus he has examined and controlled in all its details the process for the commercial assay of cyanid of potassium by MM. Fordos and Gélis;* also a process for restoring tin-foil to mirrors:—a report made by M. Felix Leblanc on the use of the submarine boats of M. Poyerne in fishing for coral and sponges;—a report of M. Barreswill on a manufacture of caoutchouc thread, just established at Grenelle by MM. Gérard and Aubert, and which constitutes a new branch of industry, as the Gerard process substitutes a thread of india rubber obtained by pressure for the uneven thread used in elastic tissues made mechanically by cutting, etc.

The "Société d'Encouragement" is occupied with a multitude of questions in applied science, but I am compelled to refer the reader for particulars to a future communication.

II. Chemistry and Physics.

1. *Specific heat of gases and vapors.*—Regnault has communicated to the Academy of Sciences some of the numerical results obtained in an elaborate investigation of this important and hitherto little understood subject. The details of the methods employed are not given by the author in the sketch furnished by him to the Academy, and we therefore can give in this place only the numerical data themselves. These are as follows. The column A gives the specific heats by weight, and B by volume.

* This Journal, xv, p. 112.

	A.	B.
Air,	0·2377	
Oxygen,	0·2182	0·2412
Nitrogen,	0·2444	0·2370
Hydrogen,	3·4046	0·2356
Chlorine,	0·1214	0·2962
Bromine,	0·0551	0·2992
Nitrous oxyd,	0·2238	0·3413
Nitric oxyd,	0·2315	0·2406
Oxyd of carbon,	0·2479	0·2399
Carbonic acid,	0·2164	0·3308
Bisulph. of carbon,	0·1575	0·4146
Sulphurous acid,	0·1553	0·3489
Chlorohydric acid,	0·1845	0·2302
Sulphydric acid,	0·2423	0·2886
Ammonia,	0·5080	0·2994
Protocarb. of hydrogen,	0·5929	0·3277
Bicarb. of hydrogen,	0·3694	0·3572
Vapor of water,	0·4750	0·2950
Vapor of alcohol,	0·4513	0·7171
Vapor of ether,	0·4810	1·2296
Chlorid of ethyl,	0·2737	0·6117
Bromid of ethyl,	0·1816	0·6777
Sulphid of ethyl,	0·4005	1·2568
Cyanid of ethyl,	0·4255	0·8293
Chloroforme,	0·1568	0·8310
Dutch liquid,	0·2293	0·7911
Acetic ether,	0·4008	1·2184
Acetone,	0·4125	0·8341
Benzole,	0·3754	1·0114
Oil of turpentine,	0·5061	2·3776
Chlorid of phosphorus,	0·1346	0·6386
Chlorid of arsenic,	0·1122	0·7013
Chlorid of silicon,	0·1329	0·7788
Chlorid of tin,	0·0939	0·8639
Chlorid of titanium,	0·1263	0·8634

The author directs attention to the very remarkable fact that the specific heat of the vapor of water, namely 0·475, is very nearly the same as that of ice and about half that of water itself. Other very valuable numerical data are promised in subsequent communications.—*Comptes Rendus*, xxxvi, 676, 18th April, 1853.

2. *On the decomposition of certain organic acids.*—Chiozza has studied in Gerhardt's laboratory the action of caustic potash upon acrylic, angelic and oleic acids, and has obtained results of great interest and importance for the study of the fatty acids in general. When acrylate of potash is heated with an excess of caustic potash it is resolved into a mixture of formate and acetate of potash, with disengagement of pure hydrogen gas. Similar decompositions occur with angelic and oleic acids and may be represented by the following equations.

$$C_6H_4O_4 + 2KO, HO = C_4H_3O_3, KO + C_2HO_3, KO + 2H$$
$$C_{10}H_8O_4 + 2KO, HO = C_4H_3O_3, KO + C_6H_5O_3, KO + 2H$$
$$C_{36}H_{32}O_4 + 2KO, HO = C_4H_3O_3, KO + C_{32}H_{31}O_3, KO + 2H$$

These remarkable reactions not merely demonstrate the existence of a series of acids homologous with oleic acid, but exhibit the relations of this group with the formic acid series in a very striking manner. Chiozza has furthermore found that cinnamate of potash heated with excess of caustic potash yields acetate and benzoate of potash and hydrogen. The equation is

$$C_{18}H_8O_4 + 2KO, HO = C_4H_3O_4, KO + C_{14}H_5O_3, KO + 2H.$$

Thence it would appear that cinnamic acid stands in the same relation to benzoic acid that acrylic acid does to formic acid, or oleic to ethalic (palmitic) acid, and we have thus a further analogy between the acetyl and benzoyl series, or between the methyl and phenyl series.—*Comptes Rendus*, xxxvi, 701.

3. *New organic radicals containing Tin.*—Löwig has communicated the results of an elaborate investigation of the products resulting from the action of iodid of ethyl upon alloys of tin and sodium. These results are of great interest, and throw much light upon the nature and structure of organic radicals. The alloys of tin and sodium employed, were obtained by simply melting tin in an earthen crucible and adding

sodium while still moistened with naphtha. The author prefers an alloy of 1 part of sodium with 6 parts of tin which is crystalline, silver-white, and easily pulverized. It is to be quickly reduced to powder, mixed with quartz sand, and introduced into small glass flasks of three or four ounces capacity, iodid of ethyl is then added, and the flask quickly connected with a tube and condenser. The action commences almost immediately with evolution of much heat, and the excess of iodid of ethyl distils over. The flask is then to be quickly closed, and the operation repeated with a second flask, and so on till a sufficient quantity of the iodid has been consumed. After cooling, the contents of the flasks are again treated with iodid of ethyl, and the above operations repeated. After cooling again, the mass in the flasks is perfectly dry and like dust, of a yellowish color, and intolerable odor. The contents of the flasks are then introduced into a flask filled with ether, and allowed to remain one or two hours with frequent agitation. The dark yellowish brown colored solution is then to be poured into a bottle filled with carbonic acid, and permitted to stand from half an hour to an hour. During this time, a brownish substance separates, which when collected on a filter dries to a white mass without odor. The etherial solution now contains five or six organic radicals, and a number of iodine compounds: these last are present in larger quantity when the contents of the flask contain no undecomposed alloy; when this however is the case, the radicals are usually alone present. The author bases his method of separation upon the fact, that the radicals are insoluble, or nearly so in absolute alcohol, while the iodids are readily soluble even in dilute alcohol; for the details of the processes employed we must refer to the original memoir. The new substances resulting from the action of iodid of ethyl upon alloys of tin and sodium, are, according to Löwig seven in uumber, namely,

Stannethyl, - - -	Sn Ae
Methylenstannethyl, - -	Sn_2 Ae_2
Elaylstannethyl, - -	Sn_4 Ae_4
Acetylstannethyl, - -	Sn_4 Ae_3
A Radical, - - - -	Sn_6 Ae_4
Methstannethyl, - - -	Sn_2 Ae_3
Ethstannethyl, - - -	Sn_4 Ae_5

in which Ae is the symbol for ethyl C_4 H_5. Stannethyl and its compounds have already been described by Cahours and Riché, and more recently by Frankland, so that we may omit Löwig's account of this radical. The author did not succeed in isolating methylen-stannethyl Sn_2 Ae_2, but gives the description and analysis of the oxyd, iodid and chlorid, which are represented by the formulas Sn_2 Ae_2O, Sn_2 Ae_2I, and Sn_2 Ae_2Cl. The iodid and chlorid are colorless and crystalline; the oxyd is a white powder without taste or smell.

Elaylstannethyl is a colorless oily liquid of density 1·410; Sn_4 Ae_4O is a snow white amorphous powder which is precipitated from its compounds by ammonia and potash, which last when in excess dissolves it. It forms colorless salts soluble in alcohol and ether, and precipitated by water from the alcoholic solution. The author describes a colorless and crystalline nitrate, chlorid, bromid, and iodid of this radical; they are all anhydrous.

Acetylstannethyl is a colorless oily liquid which was not obtained perfectly pure; the oxyd $Sn_4\ Ae_3O$, is a white amorphous powder, soluble in caustic potash; its salts are scarcely soluble in water, but soluble in alcohol.

The nitrate $Sn_4\ Ae_3O, NO_5$ crystallizes is small brilliant crystals; the iodid $Sn_4\ Ae_3I$ in needle-like crystals grouped together; the bromid is also crystalline. The compounds of the radical $Sn_6\ Ae_4$ are not crystalline, and doubt may be entertained as to their true constitution.

Methylstannethyl appears also to be a colorless oily liquid; the oxyd was obtained as a crystalline hydrate, somewhat volatile, soluble with difficulty in water, more easily in alcohol and ether; it is represented in the formula $Sn_2\ Ae_3\ O+HO$, but contains also water of crystallization. Its taste is strongly caustic and penetrating; it takes up carbonic acid quickly from the air, and precipitates all metallic oxyds from their salts. With the single exception of nitric acid, it forms with acids finely crystallized salts. The author describes the nitrate, sulphate, iodate and bromate, as well as the iodid, bromid and chlorid. The three last are colorless oily liquids, which have a penetrating smell of oil of mustard and irritate the nose and eyes.

Ethylstannethyl appears also to be a colorless oily liquid; its compounds closely resemble those of methylstannethyl. The haloid salts of these radicals are immediately reduced by potassium and sodium, the radical being set free.

The author closes his memoir with a discussion of the theoretical signification of the results which he has obtained. He considers the constitution of the compounds of tin and ethyl as demonstrating that, in organic substances, tin may replace carbon, equivalent for equivalent, and states that he has also discovered similar bodies in which carbon is replaced by lead. The following formulas show at once the advantages, and even necessity, of this view.

Methylen,	C_2H_2	Methylen stannethyl,	Sn_2Ae_2
Elayl,	C_4H_4	Elayl stannethyl,	Sn_4Ae_4
Acetyl,	C_4H_3	Acetyl stannethyl,	Sn_4Ae_3
Methyl,	C_2H_3	Methyl stannethyl,	Sn_2Ae_3
Ethyl,	C_4H_5	Ethyl stannethyl,	Sn_4Ae_5

As these are the first instances on record of a replacement of carcarbon by another element their importance is very great. The author states further that he has reason to assert the existence of radicals composed of tin and hydrogen analogous to the hydrocarbons, and points also to the probability that compounds of carbon with ethyl and methyl exist, similar to those of tin with the same radicals.—*Journal für prakt. Chemie*, lvii, 385.

4. *On a new series of organic bodies which contain metals.*—Frankland has presented to the Royal Society a memoir on the compounds of ethyl, methyl, &c., with zinc, mercury, and other metals, a class of compounds the existence of which was first recognized by himself some years since and some of the members of which have since been investigated by other chemists. The compounds in question were all obtained by the direct action of the iodids of methyl, ethyl, and amyl

upon the metals themselves, the reaction being brought about by the influence of light, or of heat, or of both these agents. The materials employed were enclosed in glass tubes and either plunged for half their length into an oil bath, or exposed in the focus of an 18 inch parabolic concave mirror. By the action of iodid of ethyl upon metallic tin the author obtained *stannethyl*—a radical which was also obtained by Cahours and Richè, and by Löwig—and which has been fully described in this Journal. Stanmethyl and stanamyl were obtained in a similar manner, and their salts according to Frankland are isomorphous with those of stannethyl.

When iodid of methyl and zinc are exposed to a temperature of 150° C. in a closed tube, the zinc gradually dissolves with evolution of gas, while a mass of white crystals, and a colorless mobile highly refractive fluid, make their appearance. The gas evolved is methyl C_2H_3, the liquid zincmethyl, C_2H_3Zn. Zincmethyl possesses a peculiar penetrating and intolerable smell; it is very volatile and unites directly with oxygen, chlorine, iodine, &c., to form very stable compounds. In contact with air it instantly inflames and burns with a magnificent greenish blue flame with formation of white clouds of ZnO: it decomposes water with explosive violence and with evolution of heat and light. If the decomposition be moderated so as to avoid too high a temperature, oxyd of zinc and hydruret of methyl, C_2H_3, H, are the only products. The author suggests its employment as a deoxydizing agent and also to produce replacements of chlorine, &c., by methyl. Zincethyl and zincamyl are formed in a manner precisely similar to that employed in producing zincmethyl. They are both colorless liquids and unite directly with oxygen, chlorine, &c., to form well defined compounds. Hydrargyro-methyl is produced when iodid of methyl and metallic mercury are exposed for some days to the action of sunlight. The iodid C_2H_3HgI is a white crystalline substance, insoluble in water, soluble in alcohol, ether and iodid of methyl. The isolation of the radical has not yet been attempted: the author obtained the corresponding amyl compound, but iodid of ethyl gives with mercury, ethyl, hydruret of ethyl, and olefiant gas. Some preliminary experiments with other metals gave analogous results; the author mentions arsenic, antimony, chromium, iron, manganese and cadmium as promising interesting results.—*Ann. der Chemie u. Pharmacie*, lxxxv, 329.

W. G.

5. *Note on Ozone.*—In accordance with the investigations of Becquerel and Frémy, Dr. J. Schiel, of St. Louis Mo., discovered last year that ozone is oxygen in a highly electro-negative condition, and furthermore that air or oxygen ozonized by means of phosphorus, light, or any other method, may be combined with non-ozonized air or oxygen to form a galvanic circuit in which the ozonized gas is the electro-negative element. These results were obtained by Dr. Schiel before the results of the experiments of Becquerel and Frémy were made known. —*Extract from a letter of Dr. Schiel.*

III. Geology.

1. *Inundations of the Delta of the Mississippi:* The Mississippi and Ohio Rivers containing plans for the Protection of the Delta from Inundation, and Investigations of the Practicability and cost of improving the Navigation of the Ohio and other Rivers by means of Reservoirs, with an Appendix on the Bars at the Mouths of the Mississippi, by Charles Ellet, Jr., Civil Engineer. 366 pp., 8vo. Philadelphia, 1853. Lippincott, Grambo & Co.—The views in this work on the Mississippi were originally presented in a report to the War Department and published among the Executive Documents of the Senate. The surveys were directed by the Secretary of War under the authority of an act of Congress. The results of the investigations are here brought out in excellent style with numerous maps and cuts in illustration of the subject. The following citations from the Introduction of the work give an idea of the author's plan.

"The greater frequency and more alarming character of the floods are attributed—

Primarily, To the extension of cultivation throughout the Mississippi Valley, by which the evaporation is thought to be, in the aggregate, diminished, the drainage obviously increased, and the floods hurried forward more rapidly into the country below.

Secondly, To the extension of the levées along the borders of the Mississippi, and of its tributaries and outlets, by means of which the water that was formerly allowed to spread over many thousand square miles of low lands, is becoming more and more confined to the immediate channel of the river, and is, therefore, compelled to rise higher and flow faster, until, under the increased power of the current, it may have time to excavate a wider and deeper trench to give vent to the increased volume which it conveys.

Thirdly, To *cut-offs*, natural and artificial, by which the distance traversed by the stream is shortened, its slope and velocity increased, and the water consequently brought down more rapidly from the country above, and precipitated more rapidly upon the country below.

Fourthly, To the gradual progress of the delta into the sea, by which the course of the river, at its embouchure, is lengthened, the slope and velocity there are diminished, and the water consequently thrown back upon the lands above.

It is shown that each of these causes is likely to be progressive, and that the future floods throughout the length and breadth of the delta, and along the great streams tributary to the Mississippi, are destined to rise higher, as society spreads over the upper states, as population adjacent to the river increases, and the inundated low lands appreciate in value.

For the prevention of the increasing dangers growing out of these several co-operative causes, six distinct plans are discussed and advocated:—

First. Better, higher, and stronger levées in lower Louisiana, and more efficient surveillance:—a local measure, but one requiring state legislation, and official execution and discipline.

Second. The prevention of additional cut-offs; a restraint which may call for national legislation, or possibly judicial interference, to prohibit the States and individuals above from deluging the country below.

Third. The formation of an outlet of the greatest attainable capacity, from the Mississippi to the head of Lake Borgne, with a view, if possible, to convert it ultimately into the main channel of the river.

Fourth. The enlargement of the Bayou Plaquemine, for the purpose of giving prompt relief to that part of the coast which now suffers most from the floods, viz.: to the borders of the Mississippi from above Baton Rouge to New Orleans.

Fifth. The enlargement of the channel of the Atchafalaya, for the purpose of extending relief higher up the coast, and conveying to the sea, by an independent passage, the discharge from Red River and the Washita.

Sixth. The creation of great artificial RESERVOIRS, and the increase of the capacity of the lakes on the distant tributaries, by placing dams across their outlets, with apertures sufficient for their uniform discharge —so as to retain a portion of the water above until the floods have subsided below. It is proposed by this process to compensate, in some degree, for the loss of those natural reservoirs which have been and are yet to be destroyed by the levées; and, at the same time, and by the same expedient, improve the navigation of all the great tributaries of the Mississippi, while affording relief to the suffering and injured population of the delta.

It will be seen that these several plans harmonize with each other, and may be carried on simultaneously.

It will be shown, moreover, that they will all be needed, and that they must be adopted promptly and prosecuted vigorously, to afford efficient and timely protection; and that, if adopted, and pressed forward boldly, they will ultimately secure the immediate object of Congress—the protection of the coasts of the Mississippi from overflow, and, simultaneously, the perfection of twenty thousand miles of precarious navigation, and the ultimate drainage and cultivation of fifteen or twenty millions of acres of uninhabitable swamps."

As we have not space to follow the author through his argument, we only cite in this place a few from among the many valuable facts brought out by the author.

"To be able to form a just conception of the present physical constitution of the delta, and the causes of its overflow, we must imagine a great plane sloping uniformly from the mouth of the Ohio, in a direction deviating but little from a due southerly course, to the Gulf of Mexico. The length of this plane, from the mouth of this river to the waters of the gulf, is 500 miles. Its northern extremity is elevated 275 feet above the surface of the sea, and is there and every where nearly level with low water in the Mississippi River. Its total descent, following the highest surface of the soil, is about 320 feet, or at the rate of 8 inches per mile.

The breadth of this plane, near the mouth of the Ohio, in an east and west direction, is from thirty to forty miles; and at the Gulf of Mexico it spreads out to a width of about one hundred and fifty miles.

It is inclosed on the east and west by a line of bluffs of irregular height and extremely irregular direction.

This plane, containing about 40,000 square miles, has been formed in the course of ages from the material brought down from the uplands by the Mississippi and its tributaries. The river has therefore raised from the sea the soil which constitutes its own bed. It flows down this plane of its own creation, in a serpentine course, frequently crowding on the hills to the left, and once passing to the opposite side and washing the base of the bluff which makes its appearance on the west at the town of Helena.

The actual distance from the mouth of the Ohio to the coast of the gulf is, in round numbers, as stated, 500 miles. The computed length of the Mississippi River, from its confluence with the Ohio to the mouth of the Southwest Pass, is 1,178 miles; and the average descent at high water $\frac{27}{100}$ths of a foot, or $3\frac{1}{4}$ inches per mile.

The course of the river is therefore lengthened out nearly seven hundred miles, or is more than doubled by the remarkable flexures of its channel; and the rate of its descent is reduced by these flexures to less than one-half the inclination of the plane down which it flows.

In the summer and autumn, when the river is low and water is scantily supplied by its tributaries, the surface of the Mississippi is depressed at the head of the delta about forty feet, and as we approach New Orleans, twenty feet below the top of its banks. It then flows along sluggishly, in a trench about 3,000 feet wide, 75 feet deep at the head, and 120 feet at the foot, and inclosed by alluvial and often caving banks, which rise, as stated, from 20 to 40 feet above the water.

But when the autumnal rains set in, the river usually rises until the month of May, when it fills up its channel, overflows its banks, and spreads many miles over the low lands to the right and left of its trace. This leads to another important feature in the characteristics of this great stream.

The Mississippi bears along at all times, but especially in the periods of flood, a vast amount of earthy matter suspended in its waters, which the current is able to carry forward so long as the river is confined to its channel. But when the water overflows the banks, its velocity is checked, and it immediately deposits the heaviest particles which it transports, and leaves them upon its borders; and as the water continues to spread further from the banks, it continues to let down more and more of this suspended material—the heaviest particles being deposited on the banks, and the finest clay conveyed to positions most remote from the banks. The consequence is, that the borders of the river, which received the first and heaviest deposits, are raised higher above the general level of the plane than the soil which is more remote; and that, while the plane of the delta dips towards the sea at the rate of eight inches per mile, the soil adjacent to the banks slopes off at right angles to the course of the river, into the interior, for five or six miles, at the rate of three or four feet per mile."—pp. 22, 23, 24.

The width of the Mississippi in its course through the delta varies from 2200 to 5000 feet; and its depth in mid-channel, from Vicksburg to New Orleans averages 115 feet at high water, and varies between 70 and 180 feet or more. The mean velocity of the Mississippi at its

surface, according to the author, is two per cent. less than the velocity below the surface to near the bottom, and he attributes the surface retardation to contact with the atmosphere. The amount of water discharged by the Mississippi (including the discharge of the Atchafalaya) at the flood of 1850 is stated at 1,280,000 cubic feet per second. The discharge below New Orleans, at the top of the flood of 1851, was 995,000 cubic feet per second; and at Memphis, in 1850, 958,500 cubic feet. It is a remarkable fact, as the author observes, that at the same time, the discharge of water higher up the stream was much greater than this. For example, one mile below the mouth of the Ohio in June, 1851, it was 1,223,000 cubic feet, although the flood was 7 feet 10 inches below the high water of 1850; and in July 1851, at Cape Girardeau, above the mouth of the Ohio, when the water was 4 feet below the high water of 1850, it was 1,025,000 cubic feet per second. These quantities are the volumes which flowed between the banks and are independent of the waters of overflow, which enter the swamps and feed and maintain the floods below. More than 40 per cent. of the volume discharged by the channel immediately below the mouth of the Ohio, passes into the swamps of the southern counties of Missouri and the northern counties of Arkansas and escapes the measurements at Memphis.

The author treats of the local changes and irregularities of the river, arising from the crevasses, the building of levees, a change in the bends, the action of the winds, and variations in the tributaries. In the course of his remarks on the influence of the winds, he mentions that when running a test-level along both shores of Chautauque Lake, a narrow sheet of water, he detected a variation in the surface of more than 8 inches in 20 miles, produced by a continued but moderate breeze.

For the important discussions of the author upon the different modes of protection against floods, we must refer to his work.

We close by the following citations upon the Ohio river.

"This noble tributary rises on the borders of Lake Erie, at an average elevation of 1,300 feet above the surface of the sea, and nearly 700 feet above the level of the lake. The plane along which this river flows is connected with no mountain range at its northern extremity, but continues its rise with great uniformity, from the mouth of the Ohio to the brim of the basin which incloses Lake Erie. The sources of the tributary streams are generally diminutive ponds, distributed along the edge of the basin of Lake Erie, but far above its surface, and so slightly separated from it, that they may all be drained with little labor down the steep slopes into that inland sea.

From these remote sources, a boat may start with sufficient water, within seven miles of Lake Erie, in sight, sometimes, of the sails which whiten the approach to the harbor of Buffalo, and float securely down the Connewango, or Cassadaga, to the Alleghany, down the Alleghany to the Ohio, and thence uninterruptedly to the Gulf of Mexico. In all this distance of 2,400 miles, the descent is so uniform and gentle—so little accelerated by rapids—that when there is sufficient water to float the vessel, and sufficient power to govern it, the downward voyage may be performed without difficulty or danger in the channels as they were formed by nature; and the return trip might be made with equal security and success with very little aid from art."—p. 231.

Descent of the Alleghany, Ohio, and Mississippi Rivers.

	DISTANCES.	FALL.	FALL PER M.	
	Miles.	Feet.	Feet.	Inches
From Coudersport to Olean Point,	40	246	6	2
From Olean Point to Warren,	50	216	4	4
From Warren to Franklin,	70	227	3	3
From Franklin to Pittsburg,	130	261	2	
From Pittsburg to Beaver,	26	30	1	$1\frac{85}{100}$
From Beaver to Wheeling,	62	49	—	$9\frac{50}{100}$
From Wheeling to Marietta,	90	49	—	$6\frac{53}{100}$
From Marietta to Le Tart's Shoals,	31	16	—	$6\frac{17}{100}$
From Le Tart's Shoals to the mouth of Kanawha,	55	33	—	$7\frac{20}{100}$
From mouth of Kanawha to Porstmouth,	94	48	—	$6\frac{13}{100}$
From Portsmouth to Cincinnati,	105	42	—	$4\frac{80}{100}$
From Cincinnati to Evansville,	328	112	—	$4\frac{10}{100}$
From Evansville to the Gulf of Mexico,	1365	320	—	$2\frac{813}{1000}$
From Coudersport to the mouth of the Mississippi,	2446	1649		

Elevations of the Ohio River at low water.

	Feet above tide.
Mouth of Ohio, above high tide, in the Gulf of Mexico,	275
Mouth of Wabash (approximately),	297
Evansville (approximately),	320
New Albany, below the Falls,	353
Louisville, above the Falls,	377
Cincinnati,	432
Portsmouth,	474
Mouth of Great Kanawha,	522
Head of Le Tart's Shoals,	555
Marietta (mouth of Muskingum),	571
Wheeling,	620
Pittsburg,	699
Franklin,	960
Warren,	1,187
Chautauque Lake,	1,306
Olean Point,	1,403
Mouth of Oswaya,	1,419
Smithport,	1,480
Coudersport,	1,649
Surface of Lake Erie,	565

The reader will also find in Mr. Ellet's work much information on the descent of the various tributaries of the Ohio and other valuable details of geological interest.

2. *Coup d'œil sur la Constitution Géologique de Plusieurs Provinces de l'Espagne*, par MM. DE VERNEUIL et COLLOMB, *suivi d'une description de quelques Ossements Fossiles du Terrain Miocène*, par M. PAUL GERVAIS, (Extrait du Bulletin de la Soc. Geol. de France, 2nd ser., t. x, 1853. 108 pp. With maps and plates.—This memoir is throughout full

of interesting details and conclusions. The observations on which the results immediately depend were extended over a triangular space, the base of which follows the Mediterranean shore from Aliante to the vicinity of Castellon de la Plana in Valencia, and the summit lies at Madrid. The authors first describe, among the features of the surface, the great tertiary plain, or central plateau of Spain, between Madrid and Cuenca, which is 1500 square leagues (French) in surface. The average elevation of it above the sea is probably about 600 meters. Another tertiary plain of equal extent is that of the basin of the Duero, situated to the north a little to the westward, and separated from the former by the granitic chain of the Guadarrama, and having the Cantabrian chain on the north. It is nearly square, with a side to either point of the compass and has in its four corners, the villages Leon, Burgos, Salamanca and Sepulveda, and the city of Valladolid at its center. Cretaceous deposits enclose it on three sides, and metamorphic rocks, gneiss and granitic, on the other or Portugal side. Its mean height is over 700 meters.

The tertiary deposits of these two great basins are similar throughout. They are evidently lacustrine in origin, and consist of a superior calcareous bed, a median marly and gypseous, and a lower, consisting of clays, sandstone and conglomerates, every where horizontal in position; and in the last, bones of the Mastodon angustidens were found not far from Valladolid. In two mountains called Las Tetas de Viana, the tertiary rocks reach a height of 1070 meters.

The great height of these two tertiary basins above the sea is remarkable. There are other basins but they are lower, such as the basin of the Ebro, which is four or five hundred meters below those before mentioned. The authors touch upon the question of the origin of the great lakes here indicated, and remark that by the present configuration of the land there are no sufficient barriers to confine them. They were in all probability cotemporaneous and of the miocene period; and they must have existed during a long period. They occupy 2-5ths of the actual surface of Spain. It is hence evident that the present extent of Spain could not have had the rivers required to feed them; moreover, the Pyrenees which were raised at an earlier period must have prevented any ingress of waters from France. The conclusion follows that the land must have then had a wholly different configuration—and recalls involuntarily, the authors state, the Atlantis of Plato, or the opinion, more scientific, of Mr. E. Forbes, that Ireland and Spain, if not united, were so near one another that the former received from the latter some part of its actual flora.

The marine miocene beds of the coasts of Spain do not extend far towards the central plateaux. The point where they ascend highest is near the villages of Vianos, Masegoso and Villarubia, a little to the south of Alcaraz, where Pectens and Ostræas have been found in a horizontal position. It is remarkable that this point is in a line which unites the tertiary basin of Almansa with the east limit of that of the Guadalquiver and half way between the two.

The authors go on to observe, that when the tertiary beds have been thoroughly studied, it will perhaps be recognized, that in the miocene period, the Gulf of Guadalquiver communicated either by Grenada, Guadix aud Huescar, or, by a narrow passage more to the north, with

the Gulf of Murcia and isolated the Sierra Nevada and the mountains of Ronda, which then formed an island or a peninsula, separate from the continent.

M. d'Archiac has remarked (Hist. des Progrès de la Geol., ii, 841) upon the analogy in the middle tertiary period between the central plateaux of France and Spain. The two countries then constituted two peninsulas lying in a northeast and southeast direction, more or less penetrated by gulfs and having large lakes about their center. But it should be added, that the peninsula of Spain, the highest of the two, is destitute of the igneous products which during three consecutive periods were ejected through the granitic rocks of the plateau of Auvergne, and is bounded by secondary rocks that are not found in the other; and also, the lacustrine deposits in Spain have been raised to a great height, whilst the center of France, so agitated with igneous action, has apparently experienced very little change of its previous elevation.

The memoir continues with the Nummulitic, Cretaceous, Triassic and Palæozoic formations, the last including the Permian, Carboniferous and Silurian strata. The last section closes with the remark, that the lower Silurian are precisely of the same age with the Llandeilo flags of Murchison or "*Fauna Seconde*" of Barrande. There has yet been discovered no trace of the lower zone characterized by the genera Paradoxides and Olenus, or the *Lingula beds*, the "*Primordial*" of Barrande.

In the course of some observations on the "movements of the land," (p. 75) it is stated that the Peninsula limited on the north by the Pyrenees and the Cantabrian chain, is traversed obliquely from the E. N. E. to the W. S. W. by four systems of mountains; 1, the Sierra Guadarrama, which unites to the Sierras of Gredos, Gata and Estrella, and reaches quite to the ocean; 2, the mountains of Toledo; 3, the Sierra Morena, which extends into the promontory called Cape St. Vincent; 4, the high chain of the south coast which includes the Sierra Nevada, Tejeda, and Ronda. The chains may be presumed to be of different ages. The oldest occupy the center of the Peninsula; these are the mountains of Toledo and the Sierra Morena. In fact, no secondary strata have penetrated into the interior of this nucleus which is entirely palæozoic, —not even the most ancient sandstones of the trias. It is surrounded by marine or lacustrine miocene beds, which by their horizontal position seem to show that the chain has undergone no movement since their deposition. On the contrary the Sierra Guadarrama, has tilted quite strongly the chalk on its flanks, and by another oscillation has deranged the miocene. As to the chains on the north and the south, these are the most modern, or at least if they have emerged in ancient epochs, the derangements have been continued to quite a recent epoch.

Four periods of disturbance are mentioned. The *first*, separating the trias from the Palæozoic; the *second*, between the Jurassic and trias; the *third*, between the miocene and nummulitic; the *fourth*, between the miocene and pliocene. The first is well seen near Horea and Checa. The second is observed at Albarracin, etc., where the tilted jurassic beds rest on trias in a vertical or much inclined position. With reference to the third, it is quite evident that there was a general "bombement" of the surface at the end of the Cretaceous period, and at this period dates the emersion of the greatest part of the Peninsula, in the interior of which the sea has never since entered. In fact, the

nummulitic beds, unlike those of the chalk, form a zone which follows the chain of the Pyrenees, and which ascends here and there upon the coasts of the Mediterranean, but never penetrates into the interior.

The disturbance which separates the nummulitic beds from the miocene strata corresponds to one of the most agitated periods of geological history. It is that of the elevation of the Pyrenees, of the Appenines and a part of the Alps; for if the Alps have taken their defined form at a more recent epoch, it cannot be denied that between the nummulitic beds and miocene mollasse, there were disturbances and faults of vast extent.

The fourth disturbance is seen near Sabero, on the Porma and Curueño, near Fresnedo, etc., where the miocene beds have lost their horizontality.

It was after the miocene epoch that Spain was elevated to its present height above the sea. The cause seems to have had its maximum energy along a line passing by the mountains of Burgos and Soria and which extends towards Siguenza and the sources of the Tagus. The inclination of the miocene beds to the southwest was thus occasioned, a position which probably allowed the lacustrine waters of the period to flow out by the valleys along which run the Duero, the Tagus and the Guadiana.

This valuable memoir closes with a bibliography, giving a list of all papers and works hitherto published upon the Geology of Spain, extending to seven pages,—and a description of the Fossil Bones by M. Paul Gervais of Montpellier. The species of Bones figured are the Hynæarctos sivalensis, H. hemicyon, a Hipparion, Mastodon longirostris (Mast. angustidens, *partim*), Rhinoceros, a˙ molar, Antilope Boodon, Sus palæochærus, besides others undetermined.

3. *Palæontology of New York;* by James Hall. Vol. II.—The appearance of this volume was announced in our last number. It contains descriptions and figures of all the fossils yet observed by the author, in the Medina sandstone, Clinton group, Niagara group, Coralline limestone, and Onondaga salt-group. The entire number of species is 344, and the whole number of plates 101. The printing of the volume was nearly completed in 1850, and its issue has been prevented by delays in the engraving; and on this account, as its author states, it contains in some instances, species identical with, or allied to, those that have recently appeared.

The fossils of the several formations are referred to the following genera.

(1.) Medina sandstone.—*Plants*, Arthrophycus, *H.*, Scolithus, Palæophycus, Dictyolites; *Corals*, Chætetes; *Mollusca*, Lingula, Atrypa, Modiolopsis, Pleurotomaria ?, Murchisonia ?, Bucania, Oncoceras, Orthoceras, Cytherina.

(2.) Clinton group.—*Plants*, Buthotrephis, Palæophycus, Rusophycus, *H.*, Ichnophycus, *H.*; *Corals*, Graptolithus, Chætetes, Favistella, Caninia, Cyclolites, Cannapora, *H.*, Catenipora, Helopora, *H.*, Stictopora, Phænopora, *H.*, Rhinopora, *H.*, Retepora, Fenestella; *Mollusca*, Lingula, Orthis, Leptæna, Strophodonta, *H.*, Chonetes, Spirifer, Atrypa, Pentamerus, Avicula, Modiolopsis, Tellinomya, Orthonota, Pyrenomœus, *H.*, Posidonia, Cyclonema, *H.*, Platyostoma, Murchisonia, Bucania, Oncoceras, Ormoceras, Orthoceras, Cornulites, Discosorus, *H.*;

Crinoidea, Closterocrinus, *H.*, Glyptocrinus, Ichthyocrinus, Caryocrinus, Tentaculites; *Trilobites*, Cybele, *Loven*, Calymene, Acidaspis, Phacops, Ceraurus, Beyrichia, *M'Coy*.

(3.) Upper gray sandstone of the Clinton group.—Myalina, Modiolopsis, Tellinomya, Pentamerus, Leptæna, Platyostoma, Orthoceras, Homalonotus.—Ichthyodorulite.

(4.) Niagara group.—*Corals*, Streptilasma, Polydilasma, *H.*, Cania, Conophyllum, *H.*, Diplophyllum, *H.*, Syringopora, Astrocerium, *H.*, Favosites, Catenipora, Heliolites, Stromatopora, Cladopora, *H.*, Limaria, *H.*, Callopora, *H.*, Trematopora, *H.*, Striatopora, *H.*, Stictopora, Diamesopora, *H.*, Clathropora, *H.*, Retepora, Hornera, Fenestella, Polypora, Ceramopora, *H.*, Rhinopora, *H.*, Lichenalia, *H.*, Sagenella, *H.*, Dictyonema, *H.*, Inocaulis, *H.*;—*Crinoidea*, Homocrinus, *H.*, Glyptaster, *H.*, Thysanocrinus, *H.*, Myelodactylus, *H.*, Dendrocrinus, *H.*, Ichthyocrinus, *Conrad*, Lyriocrinus, *H.*, Lecanocrinus, *H.*, Macrostylocrinus, *H.*, Saccocrinus, *H.*, Eucalyptocrinus, Stephanocrinus, *Conrad*, Caryocrinus, *Say*, Melocrinites, Heterocystites, *H.*, (Cystideæ) Callocystites, *H.*, Apiocystites, *Forbes*, Hemicystites, *H.*, (Agelacrinites, *Vanux.*); *Asteriadæ*, Palæaster, *H.*; *Mollusca*, Lingula, Orbicula, Orthis, Leptæna, Spirifer, Atrypa, Avicula, Modiolopsis, Orthonota, Posidonomya? Platyostoma, *Conrad*, Acroculia, *Phillips*, Gomphoceras?, Cyrtoceras?, Orthoceras, Conularia; *Crustacea*, Bumastis, Phacops, Ceraurus, Calymene, Homalonotus, Lichas, Bronteus?, Arges, Proctus, Beyrichia, Cytherina; *Fishes* (see note below), Onchus Deweii.

(5.) Coralline limestone *of Scholarie at the base of the Helderberg*.—*Corals*, Columnaria, Diplophyllum, Favosites, Stromatopora; *Mollusca*, Orthis, Leptæna, Strophodonta, Spirifer, Atrypa, Tellinomya?, Avicula, Platyostoma, Pleurotomaria, Murchisonia?, Bucania, Bellerophon, Trochoceras, Oncoceras; *Crustacea*, Calymene, Cytherina.

Onondaga Salt-group.—Eurypterus, Pentamerus, Megalomus, *H.*, Murchisonia, Subulites, Cyclonema, Pleurotomaria, Bucania, Cyrtoceras.

Descriptions of the new genera of corals proposed by Mr. Hall in his volume were published in this Journal, vol. xi, p. 398.

We refer to the work for descriptions of the other genera as well as the species, and the excellent plates which illustrate them.

Mr. Hall's labors on the Palæontology of New York, now extended to two large quarto volumes, are yet but half finished. We trust that there will be no impediment in the way of his bringing his laborious and most valuable researches to a full completion.

Note.—In a letter to one of the editors, Mr. Hall states that Barrande has expressed to him his suspicion that the supposed Ichyodorulite, from the Niagara Group, figured on plate 71, is Crustacean. Mr. Hall observes that he had before suspected this, and adds that on reëxamination, the spine proves not to have the structure pertaining to those of fishes but rather that of a Crustacean. The articulating extremity is also Crustacean and unlike anything that has been seen in the corresponding parts of Ichthyodorulites. Mr. Hall says that we have therefore no fish remains, or none of unquestionable character, yet discovered in this part of the Silurian system. The fragments from the Clinton group, which appear to have a bony structure, have not yet been examined with a microscope.

IV. Botany and Zoology.

1. *Flora Cestrica; an Herborizing companion for the Young Botanists of Chester County, State of Pennsylvania*; by Wm. Darlington, M.D., LL.D. Third Edition, Philadelphia, Lindsay and Blakiston, 1853, pp. 498, with an introduction of 90 pages, 12mo.—The second edition of this deservedly popular work, published in 1837, was almost a model of a local Flora. To grace his 71st birth day, our worthy Nestor of American botanists, has brought out this third edition, or rather, we should say has produced a new work in its place, having carefully re-written the whole, condensed the detailed descriptions, to make room for the *Mosses, Hepaticæ and Lichens*, and arranged the whole according to the natural system. The introductory part opens with five preliminary discourses, which pleasantly discuss the scope of the science of botany, and the inducements to its study; the limits and characters of the vegetable kingdom; the doctrines of morphology; and the classification of plants, both by the artificial and the natural method. To this succeed a very full Glossary of botanical terms, a Linnæan arrangement of the genera, and a Conspectus of the natural orders, under the groups imperfectly sketched in Gray's Botanical Text-Book. In the body of the work, we miss the fuller detailed descriptions of the former edition, which were both faithful and strictly original, and therefore of great service to the botanist. These enter into our idea of a local Flora, where the moderate number of plants described does not compel the strict curtailment which the Flora of a large area imperatively requires. But we must not condemn the abridgment in the present instance, since it has made room for the Mosses, Liverworts, and even the Lichens;—the latter being here for the first time introduced into a Flora of any part of North America, except that of Michaux. Nor has the compression eliminated the characteristic touches of quaint humor and sentiment which still enliven many a page. We must not forget to state that the Mosses and Hepaticæ of this volume were elaborated by Thomas P. James, Esq., of Philadelphia, apparently with much skill and judgment, on the basis furnished by Mr. Sullivant in Gray's Manual of the Botany of the Northern States; while the account of the Lichens is contributed by Dr. E. Michener, Mr. Tuckerman's valuable Synopsis serving as the ground-work.

With such an excellent *vade mecum*, it must be a pleasure and a peculiar satisfaction to study botany in Chester County, Pennsylvania!—a county most honorably distinguished, thanks to Dr. Darlington, by the possession of a Florula of its own, for nearly thirty years, and still unique in this respect. May the excellent author and benefactor of his native county survive to see his example imitated in many other local districts of our wide country! A. G.

2. *Fungi Caroliniani Exsiccati. Fungi of Carolina, illustrated by Natural Specimens of the Species;* by H. W. Ravenel, Corresp. Memb. Acad. Nat. Sci., &c., &c. Fasc. 1. Charleston: John Russell. 1852.—As only about 30 sets of this work are issued, it will seldom be met with, except by the small, but increasing number of persons who are interested in the study of this obscure and difficult family of plants. We

copy the author's preface, as the best means of introducing the collection to notice.

"The present fasciculus is the first of a series which I propose to issue of the Fungi of Carolina. Nearly all the species have been collected in this State, and mostly in this locality. Each fasciculus will contain a century of species, of which about one-half will be peculiarly American. As materials are obtained, I shall occasionally introduce extra-Carolinian species, which may be new or interesting to American Mycology; the localities of which will be properly noted. Fasc. 2, will follow as soon as sufficient materials are collected for its issue. In the preparation of this work, I must acknowledge my great obligations to the Rev. M. J. Berkeley, of England, and also to my friend, Rev. M. A. Curtis, of this State. To the former, for the examination and determination of a large number of my specimens, Mr. Berkeley's accurate acquaintance with European and intertropical Fungi, and his extensive and well-assorted herbarium, give to his opinions a proper weight of authority in the determination of these obscure plants. To Mr. Curtis, I am indebted for most valuable information respecting the synonymy, derived from an examination of the herbarium of Schweinitz, now in the possession of the Academy of Natural Sciences, Philadelphia. The later American species of Berkeley and Curtis have all been verified by an examination of authentic specimens."

"Black Oak, South Carolina."

We need only add that the present century makes a neatly bound quarto volume; that the specimens are good and sound, and are generally supplied in sufficient quantity; in which respect it compares well with the celebrated *Stirpes Cryptogamici of Mougeot.*

Collections of this kind, authentically named, are truly needful in studying the lower Cryptogamic tribes, and the Fungi in particular; and this work will be especially interesting to European as well as American mycologists, from its exemplifying so many of the species established by Schweinitz, and lately by Messrs. Berkeley and Curtis. This merit it owes mainly to the careful revision of the specimens by our leading and best instructed mycologist, the Rev. Dr. Curtis. It is abundantly evident that the labor and expense bestowed upon the fasciculus, must exceed the price demanded by the publisher, (four dollars,) and that scientific considerations alone can stimulate the indefatigable author to carry on such an undertaking. It is to be hoped that the demand for the work, showing how much it is needed, will induce Mr. Ravenel to continue it.

A. G.

3. *Lindley's Folia Orchidacea: an Enumeration of the known species of Orchids.* Part II.—This part contains several small and mostly new genera, viz., *Sarcopodium*, *Sunipia*, *Acrochæne*, *Ione*, and *Erycina* (the latter from Mexico), and six of the twelve subgenera of the large genus *Epidendrum*, including 99 species.

Part III. and IV.—The third part, issued in February last, and the fourth, issued in April, contain the remainder of the genus *Epidendrum*, with an index of the species, 310 in number. Also 8 new genera, all but one monotypical, *Vanda*, of 25 species, and *Luisia* of 11 species.

A. G.

4. *Mohl: Investigation of the question, does Cellulose form the basis of all Vegetable Membranes.* Translated from the *Botanische Zeitung* (Berlin), Vol. 5, 1847, in *Scientific Memoirs, selected from the Transactions of Foreign Academies of Science and from Foreign Journals. Natural History*, (parts 1 and 2.) edited by Henfrey and Huxley, London.—An important memoir, detailing a series of most acute microscopical investigations made under the action of various chemical re-agents, and establishing the affirmative of this proposition, or at least, rebutting all the considerations opposed to this view by Mulder and Harting.

The three parts of this new series of *Scientific Memoirs*, the publication of which is now renewed by Taylor and Francis, contain likewise the following botanical papers: viz.,

H. Hoffmann, On the Circulation of Sap in Plants. Also from the *Botanische Zeitung.*

H. Crüger, Organographical Observations on certain Monocotyledoneæ Epigynæ (Trans. from the *Linnæa*, 1849), viz., *Musaceæ, Cannaceæ, Orchidaceæ*, &c.

W. Hofmeister, On the Development of Zostera, (from *Bot. Zeitung*,) a detailed and admirable paper. An interesting conclusion arrived at, and which Hofmeister generalizes for the whole of Monocotyledons, is, that the so-called *cotyledon* is only the upper portion of an axis of limited growth, from the side of which a bud is developed, which sprouts forth into a secondary axis, forming the future main axis of the plant; thus establishing an analogy between Monocotyledons and vascular Cryptogams, in which the main stem is always a secondary axis, springing laterally from a primary leafless axis. Fully analyzed, however, there seems to be no essential difference between a primary axis and a single cotyledon arrested early in its development.

Wichura, On the Winding (coiling and twisting) *of Leaves*, (from the Regensberg *Flora.*)—An article which is not completed at the close of Part 3. A. G.

5. *Horsfield, Plantæ Javanicæ Rariores, etc.; elab.* J. J. Bennett et R. Brown. Part. IV. London: 1852.—This work is at length completed. The botanical subjects of the concluding part are only five, the notices short, and the observations nearly confined to the plants in question. Where every word is important, we must be thankful for what we can get, but we would gladly have much more, especially since we have been kept so long waiting for it. Dr. Horsfield, our countryman, if we may still call him so after more than half a century of foreign residence, has added a large map of Java, illustrative of his researches, and a detailed account of his explorations in that island, from 1801 to 1819, as well as a Geographical Preface. The botanical observations in this part are wholly the work of Mr. Brown. They principally relate to the order *Phytocreneæ*, now for the first time well defined; to *Cardiopteris*, a plant of obscure affinity, which has two stigmas, very different from each other, the efficient one early developed and deciduous after anthesis; the other (effete) one persistent; and to the *Antidesmeæ*, illustrated by a petaliferous genus, *Benettia*, which, however, has lately been published by Tulasne under another name. A. G.

6. *Hooker, Species Filicum, being Descriptions of all known Ferns: illustrated with Plates.* London: Pamplin. Part VI, or vol. ii, part II. pp. 61–124, tab. 91–110, 8vo.—This part contains more North American species than any of its predecessors. It is principally occupied with the difficult genus *Cheilanthes*, of which 70 species are described; those of our own country being: *C. microphylla*, Swartz (New Mexico, Wright, No. 823); *C. Wrightii*, Hook. (New Mexico, Wright, No. 823); *C. Alabamensis*, Kunze (*Pteris Alabamensis*, Buckley, in this Journal, 1843); *C. tomentosa*, Link (N. Carol. to New Mexico, Wright, No. 816); *C. Bradburii*, Hook. (Upper Missouri, Bradbury. Texas, Drummond, Lindheimer, fasc. 4, No. 743); *C. vestita*, Swartz? (Missouri, &c., New Mexico, Wright, No. 818); *C. Lindheimeri*, Hook. (Texas, Lindheimer, fasc. 4, No. 744, Wright, No. 817); *C. Fendleri*, Hook. (New Mexico, Fendler, No. 1015); *C. aspera*, Hook. (New Mexico, Wright; probably from Texas);—a large addition to our known species. The other genera are *Cassebeeria*, *Onychium*, and *Hypolepis*. Of the latter we have one species, *H. Californica*, gathered at Santa Barbara, by Coulter and Nuttall. Figures of all these species are given, in a condensed form, but with much neatness. We rejoice to hear that the seventh part of this invaluable work may soon be expected. It must prove still more interesting to North American botanists.

A. G.

7. *N. B. Ward, F. R. S., &c., On the Growth of Plants in closely Glazed Cases.* Second edition. London: Van Voorst, 1852. pp. 143, 12mo.—The first edition of this little treatise, published in 1842, is doubtless well known to many of our readers; and some may remember Mr. Ward's original account of his interesting discovery of a method of growing every sort of plant in the dun atmosphere of the smokiest part of London, published in the Companion to the Botanical Magazine, in 1836. This new edition if reduced in size is increased in interest, and is embellished with tasteful illustrations on wood, several of them exhibiting approved forms of those glazed cases with which the name of our author is inseparably connected. The first chapter, on the natural conditions of plants, their relations to heat, light, and moisture, and the necessity of attending to the particular conditions, or combination of circumstances, under which each species flourishes, is illustrated by ingenious and often novel observations. The second chapter treats of the causes which interfere with the natural conditions of plants in large towns, and gives some idea of the obstacles which prevent the cultivation of even ordinary plants in the open air in London, and to some extent in other large British towns. The third, on the imitation of the natural conditions of plants in closely glazed cases, tell us how a simple incident (the accidental growth of a seedling fern and a grass in a glass bottle, in which the chrysalis of a Sphinx had been buried in some moist mould), carefully and wisely reflected on, taught Mr. Ward how to overcome these obstacles, and thus to surround himself with his favorite plants, in beautiful vegetation, while living in one of the murkiest parts of London, and even to grow with complete success such ferns as the *Trichomanes radicans*, which is utterly uncultivable in any other way. A fourth chapter treats of the conveyance of living plants

on ship-board; which brings to view one of the most important practical applications of Mr. Ward's discovery.

Sir William Hooker states that "the *Wardian cases* have been the means, in the last fifteen years, of introducing more new and valuable plants to our gardens than were imported during the preceding century; and in the character of Domestic Green Houses, i. e., as a means of cultivating plants with success in our parlors, our halls, and our drawing-rooms, they have constituted a new era in horticulture." Formerly only one plant in a thousand survived the voyage from China to England. Recently, availing himself of our author's discovery, Mr. Fortune planted 250 species of plants in these cases in China, and landed 215 of them in England, alive and healthful! The same person lately conveyed in this way 20,000 growing tea-plants, in safety and high health, from Shanghae to the Himalayas. In fact this mode of conveyance is now so universally adopted, and has proved so successful, whenever properly managed, that it is no exaggeration to say that, probably, "there is not a single portion of the civilized world which has not been more or less benefitted by the invention." An indispensable requisite to success in the transmission of living plants by this method is, that the glazed cases should be freely exposed to light. Where this cannot be done, we must be content with the former method, of conveying plants in a passive condition, closely packed in peat-moss,—a plan, however, which is only partially successful in protracted voyages. Two additional and highly interesting chapters treat of the application of the "closed" plan in improving the condition of the poor; and on its probable future applications in comparative researches in vegetable physiology, and even in the treatment of diseases. To these, as to the other topics of this work, no justice can be rendered to our author's suggestions except by lengthened quotations, which the nature of this notice does not admit of. It must suffice to direct attention to this fascinating little volume. Those who read it and who have a true fondness for growing plants, will scarcely be contented without a Ward case, of more or less pretension; which they will find an unfailing source of interest, especially during the long and total suspension of vegetation in our protracted winters. With proper management, and with the requisite amount of light, any plant may thus be cultivated. But we particularly recommend Ferns and *Lycopodia*, of the most delicate kinds, as requiring least care, and as making the prettiest appearance at all seasons. Most of these require little light; although our clear skies afford us this in abundance. So little bituminous coal is consumed, even in our largest cities, that the "fuliginous matter" with which all British towns are begrimed and rendered noxious to vegetation, here interposes no obstacle to rearing plants. Quite unlike England, the principal obstacle to the growth of delicate plants in our houses in winter, and in our grounds in summer, comes from the dryness of the air. For this, the Ward case affords a perfect remedy; as nothing is easier than to furnish a saturated atmosphere for those plants that require it, or to supply and retain the degree of moisture which suits any particular species.

A. G.

8. *Infusoria of California.*—EHRENBERG (Monatsb. der K. Pr. Akad. Wiss. Berlin, August, 1852, p. 528) gives the following lists of infusoria from Shasta City and Sacramento River, the latter locality 150 miles above the mouth of Feather River.

	Shasta City.	Sacramento River.
Polygastria: 58		
Amphora libyca,	*	*
Arcella microstoma,		*
Closterium digitus,	*	
lunula?	*?	
Cocconeis granulata,		*
lineata,		*
mexicana,		*
undulata,		*
Cocconema fusidium,		*
lanceolatum,		*
mexicanum,		*
subtile,		*
———?	*?	
Desmidium Swartzii,	*	
Difflugia assulata?	*	
liostomum,	*	
Discoplea oregonica,		*
! venusta,		*
Euastrum crenulatum,	*	
Eunotia amphioxys,	*	*
gibba,	*	*
gibberula,	*	*
granulata,		*
spherula,	*	*
turgida,		*
Fragilaria diophthalma,		*
rhabdosoma,		*
! Gaillonella californica,		*
lævis,		*
———?	*?	
Gloonema paradoxum,		*
Gomphonema Augur,	*	
clavatum,	*	
! giganteum,		*
gracile,		*
herculeanum,		*
minutissimum,		*
Gomphonema obtusum,		*
Himahtidium gracile,	*	
! quaternarium,	*	
! quinarium,	*	
Navicula affinis,	*	
sigma,		*
silicula,		*
———?	*?	
Pinnularia amphioxys,		*
borealis,		*
gastrum,		*
viridis,	*	*?
———?	*?	
Podosphenia pupula?	*?	
Stauroneis anceps,		*
Stauroptera ———?	*?	
Surirella microcora,		*?
Synedra acuta,	*	*
entomon,		*
fasciculata,	*	
ulna,		*
Phytolitharia: 15		
Amphidiscus obtusus,		*
Lithostylidium angulatum,	*	
biconcavum,	*	*
clavatum,		*
crenulatum,	*	*
denticulatum,	*	*
læve,		*
quadratum,		*
rude,	*	*
securis,		*
sevra,	*	*
Spongolithis acicularis,		*
tracheotyla,		*
ventricosa,		*

They are all freshwater forms; and out of them all, there are only five new species (those indicated by an interjection), descriptions of which are published in the paper from which we cite.

9. *Recent Researches of Prof. Agassiz.*—Prof. AGASSSIZ has recently made a rapid tour from Charleston, S. Carolina, through Alabama, Mississippi, and Louisiana, thence up the Mississippi to St. Louis, Chicago, and along by the Great Lakes to New York and Massachusetts. In a recent letter from him, addressed to J. D. DANA, dated Cambridge, June 9th, he mentions the following as some of the results of his tour.

"I have been successful in collecting specimens, especially fishes, of which I have brought home not less than *sixty* new species, mostly from the great southern and western rivers. Some of these are particularly interesting. I would mention foremost a new genus, which I

shall call *Chologaster*, very similar in general appearance to the blind fish of the Mammoth Cave, though provided with eyes; it has like Amblyopsis *the anal aperture* far advanced *under the throat*, but is *entirely deprived of ventral fins;* a very strange and unexpected combination of characters. I know but one species, Ch. cornutus, *Ag.* It is a small fish scarcely three inches long, living in the ditches of the rice fields in South Carolina. I derive its specific name from the singular form of the snout, which has two hornlike projections above.

The family of Cyprinodonts has received the most numerous additions, and among them there are again new combinations of characters. Several years ago I noticed two species of a new genus which I would call *Heterandria*, from the great difference observed between the two sexes, the males having the ventral fins near the pectorals in about the same position as in the *Thoracic* fishes, while the females have those fins in the middle of the belly as in the *Abdominals*. Of this genus I have observed several new species. They all live in dense schools in shallow waters. Another type, *Zygonectes*, presents no such sexual differences, and differs also in its habits. These fishes are constantly seen swimming on the top of the water *in pairs*, whence their name. I have found half a dozen new species of this genus.

You may remember the remarkable genus Mollinesia described by Lesueur from specimens obtained from Lake Ponchartrain and from Florida. If you do not, pray look for the figures in the Journal of the Acad. of Nat. Sci., vol. 2, to appreciate the facts here mentioned. From its structure and from the sexual differences observed among other Cyprinodonts, I have long entertained the opinion that this genus had been established upon the males of Pœcilia mutilineata also described by Lesueur (same Journal), and both admitted as distinct in the great natural history of fishes by Cuvier and Valenciennes. Having found both together in all the Gulf States, I have watched them carefully, and in Mobile as well as in New Orleans, I have seen them day after day in copulation during the months of April and May; so that their specific identity is now an established fact. I have caught hundreds of them and found all the Pœcilias to be females and all the Mollinesias males; and what is further very interesting, the females are viviparous. I have been able to trace their whole embryonic development in the body of the mother, in selecting specimens in different stages of gestation.

I do not remember whether I have already mentioned to you the existence in the United States of two families of fishes not before observed in our waters, one the *Myxinoids* with one species from Eastport in Maine, collected by W. Stimpson, the other the *Erythrinoids* of Valenciennes, or *Characini* without adipose fin of T. Müller, of which a new genus occurs in the freshwaters of our northern and middle as well as western States, with half a dozen species, some of which have been unfortunately described as Leuciscus, Fundulus and Hydrargyra, with which genera they have no affinity, while other new ones have been discovered by Professor Baird and myself. I shall call this genus *Melanura*, from the singular black mark which all species show upon the tail. But I would tire you were I to go on with my ichthyological remarks, even if I should limit myself to enumerating new genera, for I have many more of these.

I will close this long letter with one observation upon Crustacea, which may have a more immediate interest for you, if you have not yet noticed the fact yourself. On my return from Florida two years ago, I noticed among many specimens of Lupa dicantha, one in which the tail presented a triangular form intermediate between that of the male and that of the female. Unable to ascertain from a single specimen whether it was a mere variety or perhaps an improperly developed female, I awaited another opportunity for a fuller investigation, which the market of Charleston, S. C. afforded largely during the latter part of February last, when I ascertained that that form was at times as common in the market as either the males or the females, and upon careful anatomical examination, I satisfied myself farther, that these specimens *are entirely deprived of internal sexual organs*, though slight indications of the openings of the sexual organs, entirely closed up by calcareous matter, clearly indicated that they are imperfectly developed females, a kind of neuters among crabs, the great number of which leads to the supposition that they are not without function in the general economy of these animals. The tail is soldered to the carapace, the last joints only at which the alimentary canal terminates, being moveable. At the same time males and females were dissected, and showed the sexual organs in that fullness which precedes copulation. Looking afterwards for similar conditions in other species, I found in the collection of Professor L. Gibbes, specimens of Lupa cribraria, and of L. Sayi with the same conformation of their tail. * * * *

I cannot help returning to my fishes to say, that I have now *twenty species* of Lepidosteus from the United States in my collection, a good foundation upon which to base a revision of the fossil fishes. I could not say how many other new things I have collected, for I have not yet unpacked half my packages."

V. Astronomy.

1. *New Planets*, (24).—On the evening of the 5th of April, 1853, Professor Gasparis of Naples, discovered a new planet in the constellation *Leo*, in R.A. about $11^h\ 4^m$ and Decl. 6° 50′. It resembles a star of the 12th magnitude. The following elements were computed by Messrs. Förster and Krüger of Bonn, from observations at Naples, April 6 and 13, and Bonn, April 27 and May 10.

Epoch, 1853, May 10·431400, M. T. Berlin.

Mean anomaly, - -	341° 52′ 26″·3	Mean Eqx. 1853·0.
Long. asc. node, - -	32 26 35 ·3	
" perihelion, - -	213 32 44 ·2	
Angle between perih. and node,	181 6 8 ·9	
Inclination, - - -	0 53 46 ·8	
Angle of excentricity, -	14 21 14 ·2	
Log. of semi-axis major, -	0·561038	
" mean daily motion, -	2·708450	

2. (25)—On the 6th of April, M. Chacornac, at Marseilles, discovered another planet which M. Valz proposes to call *Phocæa*. It appears like a star of the 9th magnitude, and of a bluish color. Comparison

with 27363 Lalande, (*a*) and Argelander, zone 16, No. 205 (*b*) gave the following positions ;—

1853.	Marseilles M. T.	R. A.	Decl.
April 6,	$15^h\ 40^m$	$a+04^m\ 11^s{\cdot}5$	$a+11'\ 2''$
" 8,	11 58	$b+$ 1 57	$b+$ 4 22

3. (26)—Mr. Luther of the Observatory at Bilk, discovered another planet—the twenty-sixth of the asteroidal group—on the 5th of May. It is of the 10·11 magnitude. The following observed places are given ;—

1853.	Bilk, M. T.	R. A.	Decl.
May 5,	$13^h\ 0^m$	207° 40′	−10° 15′
" 14,	11 52	206 3	− 9 57

4. *First Comet of* 1853, (Astron. Journal.)—In the last number of this Journal was mentioned the discovery of a comet on the 8th of March, by Mr. G. W. Tuttle, assistant at Harvard College Observatory. This comet was first seen by Professor Secchi, at the Observatory of the Collegio Romano, on the 6th of March. It was discovered independently also by Schweizer, at Moscow on the 8th, and by Dr. Hartwig on the 10th. There is some reason for supposing this comet to be identical with that of 1664. The following elements were computed by Mr. C. W. Tuttle from the observations at Cambridge, of March 10, 18 and 29.

T. 1853, Feb. 24·165622, M. T. Greenwich.

Long. of perihelion, - -	153° 37′ 58″	Appar. Eqx.
" asc. node, - -	69 15 30	1853, Mar. 18.
Inclination, - - -	20 8 11	
Log. of perihelion dist., -	0·037938	

Motion retrogade.

5. *Second Comet of* 1853, (Astr. Jour.)—Professor Schweitzer, at Moscow, discovered a comet on the 4th of April 1853, which he describes as " small and round, about 3′ in diameter, and without a tail." He gives the following places ;—

1853.	Moscow, M. T.	R. A.	Decl.
April 4,	$15^h\ 0^m$	$20^h\ 3^m\ 20^s$	+13° 4′
" 5,	14 0	20 4 25	+13 1

VI. Miscellaneous Intelligence.

1. *Notes on the Almaden Mine, California*, in a letter from T. S. Hart, dated San Jose, Nov. 26th, 1852.—We left San José at 8 o'clock in the morning in a stage which plies daily, and after a ride of an hour and a half over a most excellent road and through as beautiful and fertile a valley as the eye ever beheld, we arrived at the beautiful village of Almaden, distant twelve miles from San José. It is situated on the bank of a small stream of the purest water I have seen in California.

There is an excellent soda spring in the midst of the village, the water of which is considered as good as the Congress or Saratoga water. There is a large bakery near it, and they use the water in mixing up their bread, and certainly make as fine bread as I ever have eaten.

The works are much more extensive than I expected to find them. We called upon the superintendant, Mr. John Young, who treated us very courteously. The buildings are nearly all new, the old ones having been mostly removed. The loads of ore are brought down by the road to a level with the top of the furnace where it is separated into coarser and finer pieces. The process of extracting the metal from the ore is very simple. The ore is placed in the furnaces where a gentle and regular heat is applied. As it diffuses itself through the ore the quicksilver contained in it sublimes and is afterwards condensed and falls by its own weight, trickles down and out at little pipes leading from the bottom of the chambers of the furnace and empties into vessels so situated as to receive it. From these pipes we saw the quicksilver falling more or less rapidly in large drops. In one vessel there must have been from 15 to 20 gallons of quicksilver. Mr. Young informs me that they manufacture about 1000 flasks per month, each flask containing 75 pounds, making 75,000 pounds per month. The flasks are all of wrought iron. The time occupied in filling the furnace and extracting all the metal from a furnace full of ore is about one week. When this is accomplished, the furnace is opened that the mass of rock may be removed to make way for another batch of ore. When these ovens are first broken open they have to be very careful not to approach them too soon, as the air is charged with the quicksilver escaping in the form of vapor, and if a person breathes it he is sure to be salivated.

After examining the works and the different processes we visited the mines, which are one and a fourth miles from the works. We procured an order from the superintendant for that purpose, as no person would be admitted without one. We started up a beautiful road cut in the side of the mountain, the road being about 25 feet wide, and rising on an angle of about 20 (?) degrees. About half way up we came to a locality of sulphate of lime, from which some fine specimens have been taken. (I also found some specimens of fluor spar and chalcedony near the soda spring.) After a fatiguing journey we reached the entrance to the mine and handing our order for admission to the manager, who appeared to be a very gentlemanly man, we were furnished with a guide. We entered a car which was pushed by our guide into the tunnel, which is a most substantial and masterly piece of workmanship, being arched over in a most thorough manner; it is about 900 feet in length, 10 feet wide, and 10 feet high, with a rail road extending the entire length. The tunnel is some 300 feet below the former outlet near the top of the mountain. We were now each furnished with a torch with which each must enlighten his own way. We were now in the bowels of the mountain with 350 feet of earth over our heads. The mouth of the tunnel did not appear as large as a man's head.

We soon commenced our explorations from chamber to chamber, which appeared to extend in a most intricate manner in almost every direction. Sometimes we descended a pole almost perpendicular for fifty feet, with merely little notches cut for the toes, and at other times ascended them. We finally came where the miners were at work; we heard the ringing of the drills and the strokes of the hammer,

and on approaching nearer we could hear the measured groan or grunt with which they accompany each stroke that they make, and when I was convinced that it did not indicate pain, as its doleful sound led me to think, it became so ludicrous that I burst out into a hearty laugh. The miners are all Mexicans and have been brought up to it from their infancy. Here was the richest *lead* they had in the mine; I obtained a number of specimens from it. They estimate that the chambers or avenues in a continuous line would extend a mile and a quarter; several have been abandoned on account of the danger of working in them.

We finally ascended to the upper outlet or that which was first executed by the Indians, who must have begun at a very early date, as they had penetrated the mountain more than sixty feet, which must have been a most arduous task with the rude stone implements they worked with. They sought the vermillion to paint themselves with. They must at times have met with terrible catastrophies; one chamber was pointed out which contained a large amount of human bones buried beneath the rock which had evidently caved in upon them where they had made their excavations too wide. Having got out into daylight once more, we found ourselves near the top of the mountain, the view from which repaid us richly for our laborious ascent. There was spread out before us a vast extent of country, including the whole range of the valley of San José, and the bay with the land bordering it on either side, as far up as San Francisco on the west, and a point opposite to it on the east. Twelve miles from us on the plain was the town of San José, a little to the left the town of Santa Clara, and still further on the village of Alviso, and the Mission of San José on the table land in the distance. This country is so rich and fertile that when its agricultural merits are fully developed and brought to bear, it will feed and maintain all the population of California.

2. *Infusoria.*—In the American Journal of Science for March, 1845, mention is made of an infusorial earth supposed to have been brought from the Bermuda Islands. The history of the specimen there given is that it was received from M. Tuomey, Esq. of Petersburg, Va., labelled "Tripoli from Bermuda;" that he had received it so labelled from some mineralogical correspondent, and did not doubt that it came from Bermuda. No other specimen has ever been procured, and all efforts to discover the locality have hitherto been unsuccessful. Inquiry at the Bermuda Islands has made it quite certain that this earth does not exist there. On this ground and because of the identity of many of the species of infusorial shells found in this specimen, with those found in the infusorial beds of Virginia and Maryland, it is conjectured that it came from the Bermuda Hundred near Richmond, Va. The discovery of the locality of this earth is a matter of considerable scientific interest, for in the abundance, novelty, variety and beauty of the infusorial forms which it contains it is unparalled. The specimen is very white, friable and light, and consists almost wholly of infusorial remains. Will not some naturalist near the Bermuda Hundred make a reconnoisance of that place and report to the editors of this Journal, and if successful forward a box of specimens?

3. *Abstract of a Meteorological Journal kept at Beloit College, Beloit, Wis., for the year* 1852.—Lat. 42° 30′ 23″ N.; Long. 12° 03′ 20″ W. from Washington; elevation above Lake Michigan, 172 feet—above the Ocean, 750 feet; by S. P. Lathrop, M.D., Professor of Chemistry and Natural History.

MONTHS.	BAROMETER.			THERMOMETER.			Clearn's of sky.*	Prevailing winds.	Inches rain & melted snow.
	Max.	Min.	Mean.	Max.	Min	Mean			
January,	29·66	28·67	29·395	58	-18	21·44	4·32	N.W. & S.W.	3·39
February,	29·73	28 24	29·155	48	0	30·26	5·70	N.W. & S.E.	·84
March,	29·80	28·40	29·121	72	4	34·00	4·22	N.W. & N.	6·75
April,	29·38	28·54	29·501	72	20	43·83	4·95	N. & N.W.	3·99
May,	29·56	28·72	29·240	85	35	60·61	6·85	S.E. & S.W.	4·75
June,	29·58	28·87	29·258	89	43	68·13	6·73	S.W. & N.W.	2·15
July,	29·56	29·07	29·300	92	51	74·16	6·70	N., S., & S.E.	3·49
August,	29·52	29·03	29·346	93	52	70 42	7·10	N.E. & S.	1·02
September,	29·58	28·40	29·314	88	37	58·58	6·40	N. & S.	2·91
October,	29·56	28·90	29·258	76	32	51·25	4·40	N. & S.	4·98
November,	29·67	28·66	29·214	50	11	31·83	4·15	S W., N. & N.W.	2·43
December,	29·56	18·47	29·254	55	– 4	24·55	3·63	S.W. & S.	3·30
Year.	29·597	28·665	29·265	93	–18	47·421	5·51	N., N.W. & S.W.	40 00

The mean temperature for the past year is 47·421, being a medium of the two previous years.

The mean temperature of the winter months of 1851–52 is 24·600, being a lower temperature than that of either of the two previous years by about 2°; the temperature for the spring months is 46·146, being 0·554 lower than that of last year, and 2°·966 higher than that of the year previous to the last. The temperature of the summer months is 70°·570, being 2°·930 higher than that of the summer months of last year and 0°·93 lower than that of the year 1850. The temperature of the autumnal months is 47°·22, being 3°·23 lower than that of the last year, and 2°·35 lower than that of the year before the last.

The average density of the atmosphere, as indicated by the barometer, is 29·265 inches, being ·074 inches lower than for the last year, and ·005 inches lower than for the year 1850.

The amount of rain and melted snow for the year is 40 inches, being 15·90 inches less than for the last year, and 11·24 inches less than for the year 1850. This amount, with the exception of the months of February and March, was quite equally distributed through the year.

The amount of snow which fell in the winter of 1851–2 was more than in either of the two previous years, being 30 inches. This amount was nearly equally distributed through the winter with the exceptions above mentioned, February having only 1·5 inches while March had 9 inches.

The crops of the last year were universally *good* crops, though not remarkable for their *great* yield. The grass was slightly affected by the dry weather in the latter part of June and late crops by the dry weather in the latter part of August, but none very seriously. Our prairie soil seems remarkable for its retention of moisture and the small

* Clearness of sky is indicated by numbers from 1 to 10; perfectly clear is marked 10.

extent to which crops upon it suffer in a *dry time* compared with that which they experience on most of the soils of New England.

The presence of a stratum of fine red clay which so generally underlies the surface-soil appears of great value in imparting this property to our soil.

The *chinch-bug* which made its appearance once in some districts two years since and was not seen last year, appeared again the past year in great numbers, doing, as some think, much damage to the wheat and some other crops.

The prevailing winds were north and northwest.

CALENDAR.—*Jan.* 19th, Splendid auroral arch from 8½ to 10 P. M.

Feb. 18th, Aurora at 10 P. M.

March 7th, Wild geese seen; 8th, thunder-storm; 10th, meadow lark singing; 11th, robins singing; 12th, star of Bethlehem up; 17th, aurora with streamers.

April 2d, Anemone in flower, wild gooseberry in leaf; 14th, wild pigeons seen, Missouri currant in leaf; 21st, ground ivy in flower; 22nd, arched aurora at 9 P. M., bloodroot in flower; 29th, rainbow in the west at 5½ A. M.

May 1st, Dielytra cucullaria, dwarf iris in flower; 4th, viola cucullata in flower; 7th, Missouri currant in flower; 8th, English cherry in flower; 10th, spring beauty and wild plum in flower; 12th, burr oak, hickory and horse-chestnut in leaf, peach and pear in blossom; 17th, Dodecatheon media in flower, black and white oak in leaf; 18th, splendid aurora from 9¾ to 11 P. M.; 22nd, blue eyed grass in flower; 24th, lilac, and fly honeysuckle in flower; 29th, snowball in flower; 31st, lady's slipper.

June, Locust in blossom; 15th, Lobelia spicata and Anemone pennsylvanica in flower; 19th, Rudbeckia rosa; 22nd, Trillium philadelphicum in flower; 23d, hairbell and yellow water lily in flower.

July 21st, Hottest day in the year, the average of the thermometer for the day being 82°·50.

Nov. 6th, First snow.

Dec. 17th, Aurora; 21st, coldest day, average of thermometer 4°50.

4. *Remarkable Clouds*, (from a letter to the Editors, dated S. Bridgewater, Mass., June 13th, 1853.)—The following phenomenon was observed at S. Bridgewater, Mass., June 5th, at 5 P. M. A slight species of cloud completely lined off the heavens into great circles, which, by applying the compass, I found to verge to points of meeting at the north and south, situated precisely in the magnetic meridian. These circles were very regularly arranged at intervals of 2½ to 3°, and were remarkably uniform in their appearance, both in regard to density and width; the width near the equinoctial being about one degree, and diminishing toward the poles.

The general density of these curvilinear clouds was *less* toward the south than toward the north, and some of them were discontinuous below the line of 10 to 15° above the horizon. In the north the continuity appeared to be complete, and their approach to the point of meeting did not obliterate their individuality; which was manifested in light lines upon a slightly dusky ground, the *general* ground of the heavens at a distance from the poles being at the time a dusky blue.

A beautiful accompaniment to this phenomenon was a halo around the sun, curiously intercepted by the intervals between these regular curvilinear clouds. The previous portion of the day had been quite clear; the wind blowing lightly from the point east by north, and remaining unaltered during the continuance of the phenomenon, which was about one hour. The course of the wind, it will be remarked, was at a right angle with the magnetic meridian. C.

5. *Tooth of Getalodus Ohioensis;* by Prof. J. M. Safford, Lebanon, Tenn.—At the Albany meeting of the American Association for the Advancement of Science, held in August, 1851, Mr. J. W. Foster spoke of the occurrence of fossil teeth in the coal measures of Cambridge, Ohio. The year before, I had been fortunate enough to discover, near Cambridge, a perfect specimen of one of these teeth. It was imbedded in limestone. At the Albany meeting it was shown to Prof. Agassiz, who pronounced it at once a new species of Getalodus. Within a few weeks I have succeeded in detaching it from the limestone. Two views of the specimen are presented. The cutting edge still retains its enamel and is finely serrated. I have named the species, provisionally, G. Ohioensis.

1.

2.

It is to be hoped that the locality will afford other characteristic specimens.

6. *Products of the Swedish Mines in* 1849, (Ann. des Mines, [5] i, 125; Annual Report of the School of Mines of Sweden.)—The whole yield of the Swedish iron mines in 1849 was 1,185,300 metric quintals of cast iron, and 868,805 of forged iron.* The exports were as follows, North America taking the second place.

	Metric quintals.
Great Britain and Ireland,	241,680
North America,	178,776
Denmark,	65,685
Portugal, Madeira, Azores, etc.,	44,530
France,	41,397
Different countries not enumerated,	175,942
	748,010

7. *Quarterly Journal of Microscopical Science: On the Application of Photography to the Representation of Microscopic Objects.*—The excellent number of the Microscopic Journal, recently issued, derives special interest from the papers it contains on the use of photography with the microscope. The process has been attempted with

* The metric quintal may be reduced to tons by multiplying by 1·971.

partial success by different photographers; but we have here an example of its successful application, by J. Delves, Esq., and an illustrating plate (pl. 7,) of great beauty and perfection, the objects figured on which (one the spiracle and trachea of the silkworm, the other, the proboscis of the fly, showing the divided absorbent tubes,) are magnified respectively 60 and 180 diameters. The following is the account by Mr. Delves of his process.

"The only arrangement necessary for the purpose is the addition to the microscope of a dark chamber, similar to that of the camera obscura, having at one end an aperture for the insertion of the eye-piece end of the compound body, and at the other a groove for carrying the ground-glass plate.

This dark chamber should not exceed 24 inches in length (the size which I have found best to adopt): if extended beyond this, the pencil of light transmitted by the object-glass is diffused over too large a surface, and a faint and unsatisfactory picture is the result. The specimens exhibited were taken at this distance, which has the additional advantage of producing a picture, in size very nearly equal to the object as seen in the microscope. The eye-piece must be removed from the compound body, and the object (being well illuminated by reflection from the concave mirror) must be adjusted and focused upon the ground-glass plate. In the production of positive pictures a slight difficulty here arises, dependent upon the 'over-correction' of the object-glass. The effect of this 'over-correction' is to project the blue rays of light beyond the other rays of the spectrum, and as the chemical properties of light reside in the violet and blue rays, it becomes necessary that the plane of the sensitive plate should coincide with the foci of these rays, and it must therefore be placed beyond the surface at which the best definition is seen; this amounts to some distance with the lower combinations, and decreases with the increase of magnifying power.

For the production of *negative* pictures the ordinary illumination is not sufficient, and recourse must be had to the sunbeam, which should be reflected upon the object by the plane mirror when powers are used not exceeding the quarter of an inch combination. It is not necessary here (when producing negatives by the sunbeam) to allow for the 'over-correction' of the object-glass, but merely to focus the object carefully upon the ground-glass plate.

With regard to the time required for the production of these photographs, unfortunately no precise rules can be given, since it must vary with the sensitiveness of the materials employed. The larger group exhibited was produced by the 'one-inch object-glass,' and the time given varied from ten seconds to one minute. The smaller group representing 'scales of Lepisma saccharina by the quarter inch and one-eight inch glasses, was taken with a more sensitive collodion; and the time from ten to fifteen seconds.'

In the production of negative pictures (from which the paper specimens were obtained) a moment's exposure to the sunbeam is sufficient when using the lowest powers, and with the highest I have varied the time from five to ten seconds.

In conclusion, I beg to submit this method which I have found so simple and successful, in the hope that the communication may be

the means of directing attention to a subject both useful and interesting, and in the confidence that most satisfactory results will yet be obtained."

There are also in this number of the Microscopical Journal, two other papers on this subject, one by George Shadbolt, Esq., and the other by Samuel Highley, junior, both full of important details, and the latter very complete in its illustrations. We cite the former, referring to that Journal for the valuable paper of Mr. Highley.

"As it is not my intention to enter into particulars of the rise and progress of this art as connected with the microscope, I will only observe that the earliest microscopic photographs which I had the pleasure of seeing were some Daguerreotypes executed by Mr. Richard Hodgson by the aid of the *direct rays of the sun;* and for these I believe he is entitled to claim the honor of having been the first to produce a picture of this kind.

But however beautiful the sharpness and detail of pictures upon metallic plates, there are many causes to confine the practice of the Daguerreotype art within such very contracted limits as to render it of little use to the microscopist; whereas the increasing beauty and sensitiveness of the Collodion process renders it a much more encouraging medium for further experiment in this direction, besides offering the additional inducement of enabling one to transmit duplicates upon paper to others engaged in similar observations at a distant place, by which comparisons of much value can be made, and without the expense and inconvenience of having to execute duplicates from the objects themselves.

As it happens that the great majority of the followers of microscopic science are mostly engaged in professional or other business pursuits during the day-time, and in most instances at a distance from home, it occurred to me that if *artificial light* could be made to act sufficiently energetically to produce microscopic pictures, it would be a very considerable advantage to a large number of persons who would otherwise not be able to avail themselves of so excellent an assistant as the photographic art; and further, that to render it practically useful, it must be done by an illumination *readily accessible* and ***inexpensive;*** I therefore determined to institute a series of experiments with this end in view, and having availed myself of all the hints thrown out by Mr. Delves, Mr. Hogg, and others, at the Microscopical meeting in October, after very many failures and no small amount of trouble, I at length was fortunate enough to meet with success as, in my opinion, to offer very considerable encouragement for further operations with a reasonable hope of a really useful result; and at the meeting of the Microscopical Society in November last I had the pleasure of exhibiting a picture of a Fly's Proboscis, produced by the aid of a very small camphene lamp. In the hope of enlisting more laborers in this field of research, I purpose detailing the 'modus operandi' which I have found most successful; trusting that, in a short time, the little seed thus sown may bring forth an abundant harvest.

I would premise that I do not advocate photography in microscopic science as a rival that will *supersede* the draughtsman, except in certain cases; and although it may in very many instances do so; it will

most assuredly *make* much more work than it takes away from those who follow the occupation of a microscopic artist.

When the object to be delineated is flat and moderately thin, as compared with the necessary power in use, a very excellent picture may be produced without any aid from the limner; but where the object is not so formed—although when under microscopic examination the mind can readily acquire a correct knowledge of the form by focusing up and down—it is evident that from the very construction of a good objective a *picture* can only be obtained in *one plane at a time*, and it will then be necessary to take several pictures in different planes. and call in the artist's aid to unite the productions. The immense amount of time and labor that can be thus saved in delineating subjects of an elaborate character can only be appreciated by those who have attempted the production of objects of this class.

It is scarcely necessary to enter into a preliminary explanation on the photographic phenemona, as it is of very little use for an entire novice in the practice of this art to commence upon microscopic subjects; I shall, therefore, presume that I am addressing those who understand the general principles of photography, and shall therefore commence with

The Arrangement of the Apparatus.—Place the microscope with the body in a horizontal position, and screw on the objective to be used, and fix the object in its proper position on the object-plate of the stage by pressing down the sliding spring-piece. Turn the mirror aside or remove it altogether, and having taken out the eye-piece, insert into the body a tube of brown paper *lined with black velvet*, in order to prevent the slightest reflection from the sides, which would infallibly spoil every picture if allowed to operate. The lens should then be removed from an ordinary photographic camera, and the latter elevated so as to bring its centre in an exact line with the axis of the microscope body, which must have its eyepiece-end inserted in the place left vacant by the removal of the camera lens, and that portion of the opening not filled up by the body may be rendered impervious to light by a piece of black cloth, velvet, or other similar material.

The lighted lamp must next be brought, so that the center of the flame is in the axis of the instrument, and its distance must depend upon the focus of the lens used to concentrate the light, for which purpose an ordinary convex lens of 2½ to 3 inches diameter, with its flat side towards the lamp, is perhaps as useful as any, provided a second plano-convex lens of that focus is interposed near the object to concentrate the light still more strongly. It is not necessary, or even desirable, that an *image* should be formed of the source of light, and consequently the spherical aberration in such an arrangement as recommended is *not* detrimental, and *may* not be advantageous.

The ground glass screen to receive the image being in its proper place in the camera, the object may be brought to a correct focus in the usual way with the coarse and fine adjustment, and this cannot be done too accurately; in fact, for delicate objects, a means of magnifying the image is absolutely requisite, and for this purpose a positive eye-piece, placed in contact with ground glass, is perhaps best.

Most achromatic objectives of the best construction are slightly over-corrected (as it is termed) for color, in order to compensate for a small amount of under correction in the eye-piece, that is to say the violet and blue rays of the spectrum are therefore projected beyond the red ones.

As it is ascertained that most of the photogenic or actinic rays are located in the violet end of the spectrum, it follows that with such a lens as is used for the microscope, the *chemical focus* will be somewhat more distant from the object than the visual focus, and it therefore becomes necessary to make some allowance for this difference.

This may be done in two ways, either by placing the sensitive plate somewhat farther off than the ground glass on which the image is received, or by altering the focus by the fine adjustment; the latter being the plan I prefer, as I find it much more accurate.

The *amount* of difference between the foci probably varies in every objective, even apparently of the same make, and can only be ascertained by direct experiment; but the following may be some guide to those who wish to experiment upon the subject.

An *inch-and-a-half* objective of Smith and Beck's make required to be *withdrawn from* the object after the correct visual focus is ascertained 1-50th of an inch, or *two turns* of *their* fine adjustment.

A *two-thirds of an inch* object-glass of same make wants a withdrawal of 1-200th of an inch, or $\frac{1}{2}$ a turn of the fine adjustmen,

A 4-10ths of an inch, about 2 divisions, or 1-1000th of an inch farther off. With the 1-4th, and higher powers, the difference between the foci is so minute that it is *practically* unimportant. The above differences are those actually existing in my own objectives, but, as before intimated, it does not follow that they will be correct for others even of the same makers.

Having arranged the apparatus, focused, and made the requisite adjustment for chemical focus, the ground glass may be removed, and the sensitive plate placed in its stead.

As in all other photographic processes, the time of exposure must be varied according to the power in use, the nature of the object to be taken, and the amount of illumination, to which, must be added in the present instance, the *medium in which* the object is mounted: but from 1 *to* 10 *minutes*' exposure is generally requisite. An explanation of the last named disturbing cause may probably be found in the beautiful discovery of Professor Stokes of the property possessed by certain transparent media of arresting the chemical rays.

Any account of the preparation of the collodion, &c. &c. would be more fitted for a work on photography, and would render the present paper much too long: moreover there is an abundance of information on photographic manipulatory details readily accessible in numerous publications, such as Mr. Robert Hunt's Manual, Mr. Bingham's, Mr. Archer's, Mr. Horne's, Mr. Hennah's, &c. &c. There are, however, one or two points which it is as well to allude to. If the film of a collodion picture be examined by the microscope, some specimens will present an appearance very much resembling condensed cellular tissue, such as that seen in the cuticle of leaves, being apparently made up of flattened irregular hexagonal cells; while others seem to consist of an entirely structureless amorphous mass; the latter sort of collodion is most suitable for microscopic purposes.

The final fixation of the picture by removal of the iodid of silver has a singular influence upon the result according to the method employed, and advantage may be taken of this in order to improve the effect according as it is desired to produce glass positives or negatives; for though all collodion pictures partake of *both* characters, one of the two *should* always be predominant.

Of course a negative is most useful, because the drawings can be multiplied upon paper almost ad infinitum, but for certain objects the amount of detail when *very delicate* is inconceivably better shown upon glass than upon paper. If then a negative picture be desired, it is best to develop with the pyrogallic acid solution, and *fix* with a solution of hyposulphite of soda; but if, on the contrary, a positive picture is the desideratum, the effect will be infinitely better by fixing with a bath of the following, viz.:—

Cyanid of potassium, - -	1½ drams.
Water, . - - -	1 pint.
Nitrate of silver, - - -	15 grains.

The cyanid to be dissolved in the water, and the crystals of nitrate of silver added, which immediately cause a curdy precipitate, but this is quickly redissolved, and the whole becomes quite translucent.

By this method of fixing, the *whites* are very much purer and brighter than when the hyposulphite is used, but the pictures do not answer so well for printing from. A still further intensity of the whites may be produced by *dereloping* the picture with a solution of the *proto-sulphate of iron*, instead of the pyrogallic acid, and afterwards fixing with the cyanid solution; there are, however, certain difficulties of manipulation to overcome. The solution is made as follows:—

Proto-sulphate of iron in crystals, - -	1 oz.
Water, - - - -	by measure 10 oz.
Sulphuric acid, - - -	" 1 oz.

This is best used by placing in a *glass* bath and *totally immersing* the plate, which should be withdrawn *the moment* the picture is perfectly developed, which will be in from 15 to 60 seconds, and it ought to be instantly plunged into a bath of plain water sufficiently copious to dilute the adherent moisture very considerably. The object of having the bath of glass, is in order to see the development of the picture, as every *second* it remains after it is fully produced, is to the detriment thereof, by causing a sort of fogginess to appear all over it.

When developed with the protosulphate of iron, the pictures may be exposed to direct daylight before the final fixing, without injury, in fact with positive benefit, according to Mr. Martin.

The causes most frequently operating to prevent the success of the process are, *first*, want of attention to the proper illumination; it is to this point more than any other that the utmost attention should be paid, and I feel confident that by well concerted measures to attain this requisite, we shall eventually be able to obtain pictures in a tithe of the time now necessary; in the second place failures more often occur from *over exposure* than from being in too short a time; thirdly, want of allowance for difference of visual and chemical foci."

8. *On optical figures produced by the disintegrated surfaces of crystals*; by Sir DAVID BREWSTER, (Phil. Mag. [4] v, 16.)—This paper describes and illustrates by figures, various optical figures obtained by the reflection of a luminous point from the disintegrated surface of a crystal. The examination of certain crystals of topaz suggested the investigation. The surfaces may be either naturally disintegrated or through the action of solvents.

An octahedron of alum, when perfect, gives a single reflection of a candle from one of its surfaces. But on immersing it for an instant in water and then drying it, there are three pencils of light diverging at angles of 120°, but not meeting at center; after a second immersion, three small images of the candle, 1, 2, 3, appear at intermediate points, around the center; and on a third immersion there is another set of three, and then still another, the previous ones changing also their forms. By placing the crystal again in a strong solution of alum, for an instant only, the particles were re-deposited, and exactly filled out what had been removed, so that the surface gave, as at first, but one image. Brewster varied the experiments in many ways, and made similar trials with fluor spar, carbonate of lime, etc., and developed the most wonderful results.

Different solvents were found to produce different optical figures. Alcohol and muriatic acid act on alum differently from water. Other remarkable changes were produced by immersing crystals in saturated solutions of salts.

Mechanical abrasion by means of a piece of sandstone, hone or file, produced in a rude manner the figures given by solution; but what was very remarkable, the figure had a reversed position, or was like what solution would produce on the opposite face.

The power of producing the optical figures may be transferred from the crystal surface to wax or isinglass; and the impressions on isinglass, enable us to see the figure by transmitted light and observe its form and dimensions with great accuracy.

9. *Aurora Borealis.*—Mr. W. J. M. RANKINE announces (in Phil. Mag., [4] iv, 452) that he has on several nights examined the light of the aurora borealis with a Nichol's prism, and has never detected any trace of polarization. The same light reflected from the surface of a river was polarized, showing that his failing to detect polarization in the direct light of the aurora was not owing to its faintness. This fact is adverse to the idea that the light of the aurora is reflected light.

10. *Meteoric stone of Lima.*—EICHWALD (Pogg. Ann., lxxxv, 574) has determined the composition of this ash gray and fine granular meteoric stone as follows:—Nickeliferous iron ·22 (iron 20, nickel 2), sulphuret of iron 9·5 (iron 6, sulphur 4·5), silica 33·2, protoxyd of iron 22·0, magnesia 10·8, alumina 1·3, lime with trace of manganese 0·5, chromium 0·7. The silicates appear to be white round grains of anorthite or labradorite, yellowish brown olivine or garnet, and black augite.

11. *American Association for the Advancement of Science.*—This Association will hold its next annual meeting at Cleveland, Ohio, during the week commencing with the 28th of July. Professor Peirce of Cambridge is the President for the year.

OBITUARY.

Death of Dr. Lewis C. Beck.—This melancholy event occurred at Albany on the 20th of April, 1853, in the 55th year of his age. At the time of his decease, he held the offices of Professor of Chemistry and Natural History at Rutgers College, New Jersey, and Professor of Chemistry in Albany Medical College. Of retiring habits, joined to great industry and devotion to science, his personal character was such as to gain him numerous and attached friends. For several years previous to his decease, his health had been feeble, and his strength apparently failing. His devotion to his duties was however unremitted.

The best memorial of Dr. Beck is a list of his writings, the most important of which are stated below.

A Gazetteer of the States of Illinois and Missouri, &c. Albany, 1823. (This work contains numerous engravings and descriptions of Indian remains, obtained from personal observation.)

*New York Medical and Physical Journal.**

Vol. 1. Facts relative to a disease generally known as *sick stomach* or *milk sickness.*

Vol. 2. Description of a new species of Ranunculus (lacustris), by L. C. Beck and James G. Tracy.

Vol. 2. An examination of the question, whether the climate of the valley of Mississippi under similar parallels of latitude is warmer than that of the Atlantic Coast.

Vol. 4. An account of the Small Pox, Varioloid and Chicken Pox, which prevailed at Albany in 1834, with remarks on the identity of these diseases and the protective powers of vaccination.

Vol. 5. An account of the Salt springs at Salina, Onondaga County, New York, with a chemical examination of the water and of the several varieties of salt manufactured at Salina and Syracuse.

Vol. 7. Notice and chemical examination of the mineral water recently discovered in the city of Albany.

Vol. 6. General views of the formation of Phosphuretted hydrogen.

Vol. 7. On the nature of the compounds usually called Chlorids of Soda, Lime, &c., with remarks on their uses as disinfecting agents.

Transactions of the Albany Institute.

Vol. 1. On the Geographical Botany of the United States. Part I.

Silliman's Journal.

Vol. 10. Contributions towards the Botany of the States of Illinois and Missouri.

Vol. 29. Researches on the Commercial Potash of the State of New York.

Vol. 36. Note on the New Brunswick Tornado or Water Spout of 1835.

Vol. 36. Notices of Native Copper, Ores of Copper and other minerals found in the vicinity of New Brunswick, New Jersey.

Vol. 42. Notice of some Trappean Minerals found in New York and New Jersey.

Vol. 45. Remarkable examples of Expansion and Contraction, &c.

Vol. 45. Views concerning Igneous Action, &c.

A Manual of Chemistry, 1831. This work passed through four editions.

Official Report on Cholera, made to Governor Throop, August, 1832. This paper gives a geographical account of its progress in this State, also its fatality, symptoms, &c. It is published in the Transactions of the State Medical Society for 1833, and was reprinted in the Edinburgh Medical and Surgical Journal.

Botany of the Northern and Middle States, arranged according to the Natural System, 1833, and 1848. (Two editions.)

The Natural History of New York—Mineralogy. In 4to. (Official Publication.)

This work was preceded by several Annual Reports to the Legi-lature on the same subject.

Adulterations of various substances used in Medicine and the Arts. 1846.

* This work was edited by his brother, John B. Beck, M.D.

At the request of the Patent Office at Washington, and of Professor Henry of the Smithsonian Institution, Dr. Beck commenced in 1848, a most laborious series of "*Researches on the Bread Stuffs of the United States.*" The Report was subsequently published at Washington.

VII. Bibliography.

1. *A History of the Fishes of Massachusetts;* by David Humphreys Storer, M.D., A.A.S. 90 pp., 4to, with 16 4to lithographic plates.—From the Transactions of the American Academy of Arts and Sciences, vol. v.—Dr. Storer, as one of the Commissioners on the Zoology of Massachusetts in the year 1839, prepared a Report on the Ichthyology of the state, which was published without illustrations. The Memoir, the first part of which is here published, will present a revision of the whole subject, with excellent figures of the species, and a large amount of additional matter. The paper before us includes the following species:

I. *Percidæ.*—Perca flavescens, *Cuv.*, Labrax lineatus, *Cuv.*, L. rufus, *Dekay*, Centropristes varius, *Storer*, Pomotis vulgaris, *Cuv.*, P. appendix, *Dekay.*

II. *Triglidæ.*—Prionotus lineatus, *Dekay*, P. palmipes, *Storer*, P. pilatus, *St.*, Dactylopterus volitans, *Cuv.*, Cottus gracilis, *Heckel*, Acanthocottus variabilis, *Girard*, A. virginianus, G. Boleosoma Olmstedi, *Agassiz*, Aspidophorus monoptergyius, *Cur.*, Cryptacanthodes (*Storer*) maculatus, Hemitripterus acadianus, *St.*, Sebastes norvegicus, *Cur.*, Gasterosteus biaculeatus, *Mitchill*, G. quadracus, *Mitchill*, G. Dekayi, *Agassiz.*

III. *Sciænidæ.*—Otolithus regalis, *Cuv.*, Umbrina nebulosa, *St.*

IV. *Sparidæ.*—Sargus ovis, *Cuv.*, Pagrus argyrops, *Cuv.*

V. *Scombridæ.*—Scomber Dekayi, *St.*, Sc. vernalis, *Mitchill*, Pelamys sarda, *Cur.*, Thynnus secundo-dorsalis, *St.*, Cybium maculatum, *Cuv.*, Trichiurus lepturus, *Lin.*, Xiphias gladius, *Lin.*, Palinurus (*Dekay*) perciformis, *Dek.*, Caranx chrysos, *Cuv.*, Argyreiosus capillaris, *Dek.*, A. unimaculatus, *Batchelder*, Seriola zonata, *Cuv.*, Temnodon saltator, *Cuv.*, Rhombus triacanthus, *Dek.*, Sphyræna borealis, *Dek.*

VI. *Atherinidæ.*—Atherina notata, *Mitchill.*

VII. *Mugilidæ.*—Mugil lineatus, *Mitchill.*

The descriptions of the species are clear and precise, and abound in details, the results of the author's careful investigations; they are accompanied with full lists of synonyms. The plates are remarkably fine, though without anatomical details. When complete, the work will be a thorough exposition of the Ichthyology of the part of our country to which it relates; and as the same species in many instances have a wide range and have relations to those of other regions, it will find readers throughout the land and among all interested in American zoology.

2. *Löwig's Principles of Organic and Physiological Chemistry;* translated by Daniel Breed, M.D., of the U. S. Patent Office.—The systematic character of this work adapts it admirably to the purpose for which it was intended, viz., as an introduction to the study of Or-

ganic Chemistry. It is at the same time a complete compend of all the facts in this department of Science. But its great value lies in its being something more than a mere catalogue of organic compounds; it is a system of organic chemistry as far as such is practicable in the present state of the science. The facts are considered in their relations to each other, and the memory is thus materially assisted in obtaining a survey of the immense field which is presented.

The work is intended as an introduction to a larger one by the same author, which has long been regarded as a standard work in Germany. His system of Organic Chemistry is, however, fully given in the present volume. It may be well to add that a large portion of the work, according to a statement made in the preface, was translated at Zürich under the supervision of the author, which fact will serve as a guarantee of its fidelity to the original. We sincerely hope that the success of this volume will authorize the translator in the execution of his intention to give to the American public Prof. Löwig's larger work on the "Chemistry of Organic Combinations."

3. *Annual of Scientific Discovery, or Year-Book of Facts in Science and Art for* 1853, exhibiting the most important discoveries and improvements in Mechanics, Useful Arts, Natural Philosophy, Chemistry, Astronomy, Meteorology, Zoology, Botany, Mineralogy, Geology, Geography, Antiquities, etc., together with a list of Recent Scientific Publications, a classified list of Patents, Obituaries of Eminent Scientific Men, notes on the Progress of Science during the year 1852, etc., edited by David A. Wells, A.M. 412 pp., 12mo. Boston, 1853, Gould & Lincoln.

4. *On Coral Reefs and Islands*, by James D. Dana; from the author's Exploring Expedition Report on Geology, with additions. 144 pp. 8vo, with two maps and numerous wood-cuts. New York, 1853. G. P. Putnam & Co.

5. *Report on the Crustacea of the Exploring Expedition under C. Wilkes, U. S. N.;* by James D. Dana. 4to. Part I, 1 to 690 pp., 1852; Part II, 690—1620 pp., with an oceanic Isothermal Chart, 1853. G. P. Putnam & Co., New York City.—The copies of this work on sale are less than 100 in number. The Atlas of 96 folio plates, will be ready in the course of the year.

6. *The Principles of Botany, as exemplified in the Cryptogamia, for the use of Schools and Colleges;* by Harland Coultas. 94 pp., 12mo. Philadelphia, 1853. Lindsay and Blakiston.

7. *Memoirs of the American Academy of Arts and Sciences. New Series.* Vol. V. Part I. 178 pp. 4to. Cambridge and Boston, 1853.

I. W. H. Emory: Astronomical, Magnetical, and Meteorological Observations, made at Panama, New Granada.

II. Winthrop Sargent: Plan of an Ancient Fortification at Marietta, Ohio. (With a Plate.)

III. Waldo J. Burnett: Researches upon the Origin, Mode of Development, and Nature of the Spermatic Particles among the Four Classes of Vertebrated Animals. (With a Plate.)

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ART. XVI.—*On an Isothermal Oceanic Chart, illustrating the Geographical Distribution of Marine animals;* by JAMES D. DANA.*

THE temperature of the waters is well known to be one of the most influential causes limiting the distribution of marine species of life. Before therefore we can make any intelligent comparison of the species of different regions, it is necessary to have some clear idea of the distribution of temperature in the surface waters of the several oceans: and, if we could add also, the results of observations at various depths beneath the surface, it would enable us still more perfectly to comprehend this subject. The surface temperature has of late years been quite extensively ascertained, and the lines of equal temperature may be drawn with considerable accuracy. But in the latter branch of thermometric investigation almost everything yet remains to be done: there are scattering observations, but none of a systematic character, followed through each season of the year.

The Map which we present in illustration of this subject presents a series of lines of equal surface temperature of the oceans. The lines are isocheimal lines, or more properly, *isocrymal* lines; and where they pass, each exhibits the mean temperature of the waters along its course for the coldest thirty consecutive days of the year. The line for 68° F., for example, passes through the ocean where 68° F., is the mean temperature for extreme cold weather. January is not always the coldest winter

* From the Author's Expl. Exped. Report on Crustacea, p. 1451.

month in this climate, neither is the winter the coldest season in all parts of the globe, especially near the equator. On this account, we do not restrict the lines to a given month, but make them more correctly the limit of the extreme cold for the year at the place.* Between the line of 74° north and 74° south of the equator, the waters do not fall for any one month below 74° F.; between 68° north and south, they do not fall below 68°.

There are several reasons why *isocrymal* are preferable to summer or *isotheral* lines. The cause which limits the distribution of species northward or southward from the equator is the cold of winter, rather than the heat of summer or even the mean temperature of the year. The mean temperature may be the same when the extremes are very widely different. When these extremes are little remote, the equable character of the seasons, and especially the mildness of the winter temperature, will favor the growth of species that would be altogether cut off by the cold winters where the extremes are more intense. On this account, lines of the greatest cold are highly important for a chart illustrating the geographical distributions of species, whether of plants or animals. At the same time, summer lines have their value: but this is true more particularly for species of the land, and fresh-water streams, and for sea-shore plants. When the summer of a continent is excessive in its warmth, as in North America, many species extend far from the tropics that would otherwise be confined within lower latitudes. But in the ocean, the extremest cold in the waters, even in the Polar regions wherever they are not solid ice, (and only in such places are marine species found,) is but a few degrees below 32° Fahrenheit. The whole range of temperature for a region is consequently small. The region which has 68° F. for its winter temperature, has about 80° for the hottest month of summer; and the line of 56° F. in the Atlantic, which has the latitudes of the state of New York, follows the same course nearly as the summer line of 70° F. In each of these cases the whole extent of the range is small, being twelve to fourteen degrees.†

In fresh-water streams, the waters, where not frozen, do not sink lower than the colder oceans, reaching at most but a few degrees below freezing. Yet the extremes are greater than for the ocean; for in the same latitudes which give for the ocean 56° and 70° F. as the limits, the land streams of America range in

* The word *isocrymal* here introduced is from the Greek ισος, *equal*, and χρυμος, *extreme cold*, and applies with sufficient precision to the lines for which it is used. These lines are not *isocheimal* lines, as these follow the *mean winter* temperature; and to use this term in the case before us, would be giving the word a signification which does not belong to it, and making confusion in the science.

† Moreover, the greatest range for all oceans is but 62° of Fahrenheit, the highest being 88°, and the lowest 26°; while the temperature of the atmosphere of the globe has a range exceeding 150°.

temperature between 30° and 80° F., and the summer warmth in such a case, may admit of the development of species that would otherwise be excluded from the region.

While then both isocrymal and isotheral lines are of importance on charts illustrating distribution over the continents, the former are pre-eminently important where the geography of marine species is to be studied.

The lines of greatest cold are preferable for marine species to those of summer heat, because of the fact also that the summer range of temperature for thirty degrees of latitude either side of the equator is exceedingly small, being but three to four degrees in the Atlantic, and six to eight degrees in the Pacific. The July isothermal for 80° F. passes near the parallel of 30°; and the extreme heat of the equatorial part of the Atlantic Ocean is rarely above 84°. The difficulty of dividing this space by convenient isothermals with so small a range is obvious.

It is also an objection to using the isotheres, that those towards the equator are much more irregular in course than the isocrymes. That of 80° for July, for example, which is given on our Map from Maury's Chart, has a very flexuous course. Moreover, the spaces between the isotheres fail to correspond as well with actual facts in geographical distribution. The courses of the cold water currents are less evident on such a chart, since the warm waters in summer to a great extent overlie the colder currents.

It is also to be noted that nothing would be gained by making the mean temperature for the year, instead of the extremes, the basis for laying down these lines, as will be inferred from the remarks already made, and from an examination of the chart itself.

The distribution of marine life is a subject of far greater simplicity than that of continental life. Besides the influence on the latter of summer temperature in connexion with that of the cold seasons, already alluded to, the following elements or conditions have to be considered:—the character of the climate, whether wet or dry;—of the surface of the region, whether sandy, fertile, marshy, etc.;—of the vegetation, whether that of dense forests, or open pasture-land, etc.;—of the level of the country, whether low, or elevated, etc. These and many other considerations come in, to influence the distribution of land species, and lead to a subdivision of the Regions into many subordinate Districts. In oceanic productions, depth and kind of bottom have an important bearing: but there is no occasion to consider the moisture or dryness of the climate; and the influence of the other peculiarities of region mentioned is much less potent than with continental life.

We would add here, that the data for the construction of this chart have been gathered, as regards the North Atlantic, from the isothermal chart of Lieutenant Maury, in which a vast amount of facts are registered, the result of great labor and study. For the

rest of the Atlantic and the other oceans we have employed the Meteorological volume of Captain Wilkes of the Exploring Expedition Reports, which embraces observations in all the oceans and valuable deductions therefrom; also, the records of other travellers, as Humboldt. Duperey of the Coquille, D'Urville of the Astrolabe, Kotzebue, Beechey, Fitzroy, Vaillant of the Bonite, Ross in his Antarctic Voyage, together with such isolated tables as have been met with in different Journals. The lines we have laid down, are not however, those of any chart previously constructed, for the reason stated, that they mark the positions where a given temperature is the mean of the coldest month (or coldest thirty consecutive days) of the year, instead of those where this temperature is the mean annual or monthly heat; and hence, the apparent discrepancies, which may be observed, on comparing it with isothermal charts.

The isocrymal lines adopted for the chart are those of 80°, 74°, 68°, 62°, 56°, 50°, 44°, and 35° of Fahrenheit. The temperatures diminish by 6°, excepting the last, which is 9° less than 44°.

In adopting these lines in preference to those of other degrees of temperature, we have been guided, in the first place, by the great fact, that the isocryme of 68° is the boundary line of the coral-reef seas, as explained by the author in his Report on Zoophytes.* Beyond this line either side of the equator, we have no species of true Madrepora, Astræa, Meandrina or Porites; below this line, these corals abound and form extensive reefs. This line is hence an important starting point in any map illustrating the geography of marine life. Passing beyond the regions of coral reefs, we leave behind large numbers of Mollusca and Radiata, and the boundary marks an abrupt transition in zoological geography.

The next line below that of 68° F., is that of 74° F. The corals of the Hawaiian Islands, and the Mollusca also to a considerable extent, differ somewhat strikingly from those of the Feejees. The species of Astræa and Meandrina are fewer, and those of Porites and Pocillopora more abundant, or at least constitute a much larger proportion of the reef material. These genera of corals include the hardier species; for where they occur in the equatorial regions they are found to experience the greatest range in the condition of purity of the waters, and also the longest exposures out of water. Their abundance at the Hawaiian Islands, as at Oahu, is hence a consequence of their hardier character, and not a mere region peculiarity independent of temperature. There are grounds, therefore, for drawing a line between the Hawaiian Islands and the Feejees; and as the temperature at

* In the author's Report on Geology, 66° F. is set down as the limiting temperature of Coral-reef Seas; this, however, is given as the *extreme* cold. 68° appears to be the *mean* of the coldest month, and is therefore here used.

the latter sinks to 74½° F. some parts of the year, 74° F. is taken as the limiting temperature. The Feejee seas are exceedingly prolific and varied in tropical species. The corals grow in great luxuriance, exceeding in extent and beauty anything elsewhere observed by the writer in the tropics. The ocean between 74° F., north of the equator, and 74° F. south, is therefore the proper tropical or torrid region of zoological life.

With respect to the line of 80° F., we are not satisfied that it is of much importance as regards the distribution of species. The range from the hottest waters of the ocean 88° to 74° F. is but fourteen degrees, and there are probably few species occurring within the region that demand a less range. Still, investigations hereafter made, may show that the hot waters limited by the isocryme of 80° include some peculiar species. At Sydney Island and Fakaafo, within this hot area, there appeared to be among corals a rather greater prevalence than usual of the genus Manopora, which as these are tender species, may perhaps show that the waters are less favorable for hardier corals than those of the Feejees, where the range of temperature is from 70° to 80° F.; but this would be a hasty conclusion, without more extended observations. The author was on these islands only for a few hours, and his collections were afterwards lost at the wreck of the Peacock, just as the vessel was terminating the voyage by entering the Columbia River.

It is unnecessary to remark particularly upon the fitness of the other isocrymals for the purposes of illustrating the geographical distribution of marine species, as this will become apparent from the explanations on the following pages.

The regions thus bounded require, for convenience of designation, separate names, and the following are therefore proposed. They constitute three larger groups: the *first*, the *Torrid* zone or *Coral-reef* seas, including all below the isocryme of 68° F.; the *second*, the *Temperate* zone of the oceans, or the surface between the isocrymes of 68° F. and 35° F.; the *third*, the *Frigid zone*, or the waters beyond the isocryme of 35° F.

Regions.	Isocrymal limits.
I. TORRID OR CORAL-REEF ZONE.	
1. Supertorrid,	80° F. to 80° F.
2. Torrid,	80° to 74°
3. Subtorrid,	74° to 68°
II. TEMPERATE ZONE.	
1. Warm Temperate,	68° to 62°
2. Temperate,	62° to 56°
3. Subtemperate,	56° to 50°
4. Cold Temperate,	50° to 44°
5. Subfrigid,	44° to 35°
III. FRIGID ZONE.	
1. Frigid,	35° to 26°

A ninth region—called the Polar—may be added, if it should be found that the distribution of species living in the Frigid zone requires it. There are organisms that occur in the ice and snow itself of the polar regions; but these should be classed with the animals of the continents; and the continental isotherms or isocrymes, rather than the oceanic, are required for elucidating their distribution.

It seems necessary to state here the authorities for some of the more important positions in these lines, and we therefore run over the observations, mentioning a few of most interest. There is less necessity for many particulars with reference to the North Atlantic, as our facts are mainly derived from Lieut. Maury's Chart, to which the author would refer his readers.

1. North Atlantic.—*Isocryme of* 74° F.—This isocryme passes near the reefs of Key West, and terminates at the northeast cape of Yucatan; it rises into a narrow flexure parallel with Florida along the Gulf Stream, and then continues on between the Little and Great Bahamas. To the eastward, near the African Coast, it has a flexure northward, arising from the hot waters along the coast of Guinea. which reach in a slight current upward towards the Cape Verde Islands. The line passes to the south of these islands, at which group, Fitzroy, in January of 1852, found the sea temperatures 71° and 72° F.

Isocryme of 68° F.—Cape Canaveral, in latitude 27° 30′, just north of the limit of coral reefs on the east coast of Florida, is the western termination of the line of 68°. The Gulf Stream occasions a bend in this line to 36° north, and the polar current, east of it, throws it southward again as far as 29° north. Westward it inclines much to the south, and terminates just south of Cape Verde, the eastern cape of Africa. Sabine found a temperature of 64° to 65° F. off Goree, below Cape Verde, January, 1822; and on February 9, 1822, he obtained 66½° near the Bissao shoals. These temperatures of the cold season contrast strikingly with those of the warm season. Even in May (1831), Beechey had a temperature of 86° off the mouth of Rio Grande, between the parallels of 11° and 12° north.

Isocryme of 62° F.—This isocryme leaves the American coast at Cape Hatteras, in latitude 35½° north, where a bend in the outline of the continent prevents the southward extension of the polar currents close along the shores. It passes near Madeira, and bends southward reaching Africa nearly in the latitude of the Canaries.

Isocrymes of 56° *and* 50° F.—Cape Hatteras, for a like reason, is the limit of the isocrymes of 56° and 50° as well as of 62°, there being no interval between them on the American coast. The line of 56° F. has a deep northward flexure between the meridians of 35° and 40° west, arising from the waters of the

Gulf Stream, which here (after a previous east and west course, occasioned by the Newfoundland Bank, and the Polar Current with its icebergs) bends again northeastward, besides continuing in part eastward. The Polar Current sometimes causes a narrow reversed flexure, just to the east of the Gulf Stream flexure. Towards Europe, the line bends southward, and passes to the southwest Cape of Portugal. Cape St. Vincent, or, perhaps to the north cape of the Straits of Gibraltar. Vaillant in the Bonite, found the sea-temperature at Cadiz in February, 49½° to 56° F. (9·7° to 13·4° C.), which would indicate that Cadiz, although so far south (and within sixty miles of Gibraltar), experiences at least as low a mean temperature as 56° F. for a month or more of the winter season. We have, however, drawn the line to Cape St. Vincent, which is in nearly the same latitude. Between Toulon and Cadiz, the temperature of the Mediterranean in February, according to Vaillant, was 55½° to 60¼° F. (13·1° to 15·7° C.), and it is probable, therefore, that Gibraltar and the portion of the Mediterranean Sea east and north to Marseilles, fall within the *Temperate* Region, between the isocrymes of 56° and 62° F., while the portion beyond Sardinia and the coast by Algiers is in the *Warm Temperate* Region, between the isocrymes of 62° and 68° F.

The line of 50° F., through the middle of the ocean, has the latitude nearly of the southern cape at the entrance of the British Channel; but approaching Europe it bends downward to the coast of Portugal. The low temperature of 49½° observed by Vaillant at Cadiz would carry it almost to this port, if this were the mean sea-temperature of a month, instead of an extreme within the bay. The line appears to terminate near latitude 42°, or six degrees north of the isocryme of 56°. This allows for a diminution of a degree Fahrenheit of temperature for a degree of latitude. A temperature as low as 61° F. has been observed at several points within five degrees of this coast in *July*, and a temperature of 52° F., in February. Vigo Bay, just north of 42° north, lies with its entrance opening westward, well calculated to receive the colder waters from the north; and at this place, according to Mr. R. Mac Andrew, who made several dredgings with reference to the geographical distribution of species, the Mollusca have the character rather of those of the British Channel than of the Mediterranean.*

Isocryme of 44° F.—This line commences on the west, at Cape Cod, where there is a remarkable transition in species, and a natural boundary between the south and the north. The cold waters from the north and the ice of Newfoundland Banks, press the line close upon those of 50° and 56° F. But after getting beyond these influences, it rapidly rises to the north, owing to the

* Rep. Brit. Assoc., 1850, p. 264.

expansion of the Gulf Stream in that direction, and forms a large fold between Britain and Iceland; it then bends south again and curves around to the west coast of Ireland.

Isocryme of 35° F.—This line has a bend between Norway and Iceland like that of 44°, and from the same cause,—the influence of the Gulf Stream. But its exact position in this part has not been ascertained.

2. South Atlantic.—*Isocryme of* 74° F.—This line begins just south of Bahia, where Fitzroy found in August (the last winter month) a temperature of 74° to 75½° F. During the same month he had 75½° to 76½° F. at Pernambuco, five degrees to the north. Off Bahia, the temperature was two degrees warmer than near the coast, owing to the warm tropical current, which bends the isocryme south to latitude 17° and 18°, and the cold waters that come up the coast from the south. The line gradually rises northward, as it goes west, and passes the equator on the meridian of Greenwich. Sabine, in a route nearly straight from Ascension Island, in 8° south, to the African coast under the equator, obtained in June (not the *coldest* winter month) the temperatures 78°, 77°, 74°, 72·8°, 72·5°, 73°, the temperature thus diminishing on approaching the coast, although at the same time nearing the equator, and finally reaching it within a few miles. These observations in June show that the isocryme of 74° F. passes north of the equator. The temperatures mentioned in Maury's Chart afford the same conclusion, and lead to its position as laid down.

Isocryme of 68° F.—On October 23d to 25th, 1834, Mr. D. J. Browne, on board the U. S. Ship Erie, found the temperature of the sea on entering the harbor of Rio Janeiro, 67½° to 68½° F. Fitzroy on July 6, left the harbor with the sea temperature 70½° F. Beechey, in August, 1825, obtained the temperature 68·16° to 69·66° F. off the harbor. The isocryme of 68° F. commences therefore near Rio, not far south of this harbor. Eastward of the harbor, the temperature increases two to four degrees. In July, Fitzroy carried a temperature above 68° as far south as 33° 16′ south, longitude 50° 10′ west, the water giving at this time 68½ to 69½° F. Beechey in August obtained 68° F. in 31° south, 46° west. The isocryme of 68° F. thus bends far south, reaching at least the parallel of 30°. It takes a course nearly parallel with the line of 74° F., as different observations show, and passing just south of St. Helena, reaches the African coast, near latitude 7° south. Fitzroy, on July 10 (mid-winter), had a sea-temperature of 68½° near St. Helena; and Vaillant, in the Bonite, in September found the sea-temperature 68·7° to 69·26° F.

Isocrymes of 56° *and* 50° F.—These two isocrymes leave the American coast rather nearly together. The former commences just north of the entrance of the La Plata. Fitzroy, in July 23

to 31, 1832, found the sea-temperature at Montevideo 56° to 58° F., and in August, 57° to 54½° F. These observations would lead to 56° F. as nearly the mean of the coldest month. The temperature 56 F. was also observed in 35° south, 53° west, and at 36° south, 56° 36′ west. But on July 10 and 13, 1833, at Montevideo, the sea-temperature was 46½° to 47½°, a degree of cold which, although only occasional, throws the line of 56° F. to the north of this place. The temperature near the land is several degrees of Fahrenheit lower than at sea three to eight degrees distant. East of the mouth of the La Plata, near longitude 30° west, Beechey, in July, 1828, found the temperature of the sea 61·86° F. So in April 23 to 29, Vaillant obtained the temperature 59·5° to 61·25° F. at Montevideo, while in 35° 5′ south, 49° 23′ west, on April 14, it was 66·2° F., and farther south, in 37° 42′ south, 53° 28′ west, April 30, it was 64·4° F.; and in 39° 19′ south, 54° 32′ west, on May 1, it was 57¾° F.; but a little to the westward, on May 2, in 40° 30′ south, 56° 54′ west, the temperature was 48° F., an abrupt transition to the colder shore waters. Beechey, in 39° 31′ south, 45° 13′ west, on August 28 (last of winter), found the temperature 57·25° F., and on the 29th, in 40° 27′ south, 45° 46′ west, it was 54·20°; while on the next day, in 42° 27′ south, 45° 11′ west, the temperature fell to 47·83° F. These and other observations serve to fix the position of the isocryme of 56° F. It approaches the African coast, in 32° south, but bends upward, owing to cold waters near the land. On August 20, Vaillant, in 33° 43′ south, 15° 51′ east, found the temperature 56° F.; while on the 22d, in the same latitude, and 14° 51′ east (or one degree farther to the westward), the temperature was 57·74° F., being nearly two degrees warmer. At Cape Town, in June (latitude 34°), Fitzroy found 55° to 61° F., while on August 16, farther south, in 35° 4′ south, and 15° 40′ west, one hundred and fifty miles from the Cape, Vaillant found the temperature 59·26° F. The high temperature of the last is due to the warm waters that come from the Indian Ocean, and which afford 61° to 64° F. in August, off the south extremity of Africa, west of the meridian of Cape Town.

The isocryme of 50° F. leaves the American coast just south of the La Plata; after bending southwardly to the parallel of 41°, it passes east nearly parallel with the line of 56° F. It does not reach the African coast.

Isocrymes of 44° *and* 35° F.—Fitzroy in August (the last winter month) of 1833, found the sea-temperature at Rio Negro (latitude 41° south) 48½° to 50° F. But during the voyage from the La Plata to Rio Negro, a few days before, a temperature of 44½° to 46° was met with; this was in the same month in which the low temperature mentioned above was found at Montevideo. The bend in the course north of the entrance to

the La Plata, is to some extent, a limit between the warmer waters of the north, and the colder waters from the south; not an impassible limit, but one which is marked often by a more abrupt transition than occurs elsewhere along this part of the coast. The water was generally three or four degrees colder at Montevideo, than at Maldonado, the latter port being hardly sheltered from the influence of the tropical waters, while Montevideo is wholly so. The exact point where the line of 44° F. reaches the coast is somewhat uncertain; yet the fact of its being south of Rio Negro is obvious. After leaving the coast, it passes north of 47½° south, in longitude 53° west, where Beechey, in July, 1828, found the sea-temperature 40·70° F.

The line of 35° F. through the middle of the South Atlantic, follows nearly the parallel of 50°; but towards South America it bends southward and passes south of the Falklands and Fuegia. At the Falklands, Captain Ross, in 1842, found the mean temperature of the sea for July, 38·73°, and for August, 38·10°; while in the middle of the Atlantic, on March 24, latitude 52° 31′ south, and longitude 8° 8′ east, the temperature was down to 34·3° F., and in 50° 18′ south, 7° 15′ east, it was 37° F.; March 20, in 54° 7′ south on the meridian of Greenwich, it was 33·4° F. The month of March would not give the coldest temperature.

The temperature of the sea along the south coast of Fuegia sinks almost to 35°, if not quite, and the line of 35° therfore runs very near Cape Horn, if not actually touching upon Fuegia.

North Pacific Ocean.—*Isocryme of* 80° F.—The waters of the Atlantic in the warmest regions, sink below 80° F. in the colder season, and there is therefore no proper Supertorrid Region in that ocean. In the Gulf of Mexico, where the heat rises at times to 85° F., it sinks in other seasons to 74° and in some parts, even to 72° F.; and along the Thermal equator across the ocean, the temperature is in some portions of the year 78°, and in many places 74°.

But in the Pacific, where the temperature of the waters rises in some places to 88° F., there is a small region in which through all seasons, the heat is never below 80°. It is a narrow area, extending from 165° east to 148° west, and from 7½° north to 11° south. In going from the Feejees in August, and crossing between the meridians of 170° west and 180°, the temperature of the waters, according to Captain Wilkes, increased from 79° to 84° F., the last temperature being met with in latitude 5° south, longitude 175° west and from this, going northward, there was a slow decrease of temperature. The Ship Relief, of the Expedition, in October, found nearly the same temperature (83½°) in the same latitude and longitude 177° west.* But the Peacock, in

* See, for these facts, Captain Wilkes's Report on the Meteorology of the Expedition.

January and February (*summer* months), found the sea-temperature 85° to 88° F., near Fakaafo, in latitude 10° south, and longitude 171° west. In latitude 5° south and the same longitude, on the 16th of January, the temperature was 84°; in 3° south, January 10th, it was 83° F.; on March 26th, in 5° south, and longitude 175° east, the temperature was 86° F.; on April 10th, in the same longitude, under the equator, at the Kingsmills, the temperature was 83½° F.; on May 2d, at 5° north, longitude 174° east, 83½° F.; May 5th, latitude 10°, longitude 169° east, 82° F. The fact that the region of greatest heat in the Middle Pacific is south of the equator, as it has been laid down by different authors, is thus evident; the limits of a circumscribed region of hot waters in this part of the Pacific, were first drawn out by Captain Wilkes.

Another Supertorrid region may exist in the Indian Ocean, about its northwestern portion; but we have not sufficient information for laying down its limits.

Isocryme of 74° F.—At San Blas, on the Coast of Mexico, Beechey found the mean temperature of the sea for December, 1827, 74·63° F.; for January, 73·69° F.; for February, 72·40° F. The line of 74° F. commences therefore a degree or two south of San Blas. In the winter of 1827 on January 16 to 18, the temperature of 74·3° to 74·6° F. was found by Beechey, in 16° 4′ to 16° 15′ north, 132° 40′ to 135° west; and farther west, in the same latitude, longitude 141° 58′ west, the temperature was 74·83° F. West of the Sandwich Islands, near the parallel of 20° north, the temperature rises five degrees in passing from the meridian of 165° west to 150° east, and the isocryme of 74° F., consequently trends somewhat to the north, over this part of the ocean. Between the meridians of 130° and 140° east, the temperature of the sea is quite uniform, indicating no northward flexure; and west of 130° east, nearing China, there is a rapid decrease of temperature, bending the line far south. Vaillant of the Bonite, found the sea of Cochin China, in latitude 12° 16′ north, 109° 28′ east, to have the temperature 74·12° F.; and even at Singapore, almost under the equator, the temperature on February 17 to 21, was 77·54° to 79·34° F. The isocryme of 71° F. terminates therefore upon the southeastern coast of Cochin China.

Isocryme of 68°—Off the Gulf of California, in 25° north, 117° west, Beechey obtained for the temperatue of the sea on December 13, 65° F.; on December 15, in 23° 28′ north (same latitude with the extremity of the peninsula of California), 115° west, a temperature of 69·41° F. The line of 68° will pass from the extremity of this peninsula, the temperature of the coast below, as it is shut off mostly from the more northern or cold waters, being much warmer. The temperature 69·41° in the middle of De-

cember, is probably two and a half degrees above the cold of the coldest month, judging from the relative temperatures of the latter half of December and the month of February at San Blas. Leaving California, the isocryme of 68° will therfore bend a little southerly to 22½°, in longitude 115° west. In 23° 56′ north, 128° 33′ west, Beechey, on January 11, found the temperature of the sea 67·83° F. The line of 68° passes north of the Sandwich Islands. The mean temperature of the sea at Oahu in February, 1827, was 69·69° F.

Near China, this isocryme is bent far south. At Macao, in winter, Vaillant found the sea-temperature, on January 4, 59° F.; on January 5 to 10, 52·7° to 50° F.; January 11, 12, 49·87° to 48·74° F.; January 13 to 16, 50·9° to 52·16° F.; and at Touranne in Cochin China, on February 6 to 24, the sea-temperature was 68° to 68½° F.; in 16° 22′ north, 108° 11′ east, on January 24, it was 67°; in 12° 16′ north, 109° 28′ east, it was 74·12° F. The very low Macao temperature is that of the surface of the Bay itself, due to the cold of the land, and not probably, as the other observations show, of the sea outside.

The line, before passing south, bends northward to the southeast shore of Niphon, which is far warmer than the southeast coast, along Kiusiu. In the Report of the Morrison's visit to Jeddo (Chinese Repository for 1837), a coral bottom is spoken of, as having been encountered in the harbor of Jeddo. According to Siebold (Crust. Faun. Japon., p. ix.), the mean winter temperature (air) of Jeddo is 57° F.; while that of Nagasaki, although farther south, is 44° F.

Isocryme of 62° F.—On January 8, 1827, Beechey found in 29° 42′ north, 126° 37′ west, the temperature 62·75° F.; while on the preceding day, 32° 42′ north, 125° 43′ west, the sea-temperature was 60·5° F. Again, on December 11, in 29° north, 120° west, the temperature was 62·58° F.

Isocryme of 56° F.—At Monterey, on January 1 to 5, the sea-temperature according to Beechey was 56°; but the mean temperature of the sea for November 1 to 17, was 54·91°. In the Yellow Sea, the January temperature is 50° to 56° F., and the line of 56° begins south of Chusan.

Isocryme of 50° F.—At San Francisco, from November 18 to December 5, 1826, Beechey found the mean sea-temperature to be 51·14° F., and off Monterey, in longitude 123° west, the temperature was 50·75° F., on December 6. But in December of 1826, the mean sea-temperature at San Francisco was 54·78° F.; and for November, 60·16° F. The line of 50° F. (mean of the coldest thirty consecutive days), probably leaves the coast at Cape Mendocino.

Isocrymes of 44° *and* 35° F.—Captain Wilkes found the temperature off the mouth of the Columbia River, through ten de-

grees of longitude, 48° to 49° F., during the last of April, 1841. The isocryme of 44° would probably reach the coast not far north of this place. The temperature on October 21, in the same latitude, but farther west, 147° west, was 52·08° F. On October 16, in 50° north, 169° west, the temperature was 44·91° F. According to some oceanic temperatures for the North Pacific, obtained from Lieutenant Maury, the sea-temperature off northern Niphon, in 41° north and 142½° east, was 44° F., in March, showing the influence of the cold Polar current; and in 42° north, and 149½° east, it was 43° F. The line of 44° hence bends southward as far as latitude 40° north, on the Japan coast.

Again in March, in 43° 50′ north, 151° east, the sea-temperature, was 41° F.; in 44° 50′ north, 152° 10′ east, 39° F.; in 46° 20′ north, 156° east, 33° F.; in 49° north, 157° east, 33° F.; and at the same time, west of Kamschatka, in 55° north, 153° east, 38° F.; in 55° 50′ north, 153° west, 38° F. The line of 35° consequently makes a deep bend, nearly to 45° north, along the Kurile Islands.

South Pacific.—*Isocrymes of* 74°, 68°, *and* 62° F.—The temperature of the sea at Guayaquil, on August 3d, was found by Vaillant, to be, in the river, from 70½° to 73½° F., and at the Puna anchorage, August 5 to 12, 74·7° to 75·2° F. But off the coast, August 15, in 2° 22′ south, 81° 42′ west, the temperature was 69·8° F.; and the next day, in 1° 25′ south, 84° 12′ west, it was 70° F.; on the 17th, 1° south, 87° 42′ west, it was 71·28° F.; and on the 14th, nearer the shore of Guayaquil, in 3° 18′ south, 80° 28′ west, it was 78° F. Again, at Payta, one hundred miles south of Guayaquil, in 5° south, the sea-temperature was found by Vaillant, July 26 to 31, to be 60·8° to 61½° F. The isocryme of 74° F., consequently leaves the coast just north of the bay of Guayaquil, while those of 68° and 62° F., both commence between Guayaquil and Payta. Payta is situated so far out on the western cape of South America that it receives the cold waters of the south, while Guayaquil is beyond Cape Blanco, and protected by it from a southern current. At the Gallapagos, Fitzroy found the temperature as low as 58½° F. on the 29th of September, and the mean for the day was 62°. The average for September was, however, nearer 66°. The Gallapagos appear therefore, to lie in the Warm Temperate Region, between the isocrymes of 62° and 68° F. Fitzroy, in going from Callao to the Gallapagos, early in September, left a sea-temperature of 57° F. at Callao, passed 62° F. in 9° 58′ north, and 79° 42′ west, and on the 15th, found 68½° F. off Barrington Island, one of the Gallapagos.

In the warm season, the cold waters about the Gallapagos have narrow limits; Beechey found a sea-temperature of 83·58° on the

30th of March, 1827, just south of the equator, in 100° west. But in October, Fitzroy, going westward and southward from the Gallapagos, found a sea-temperature of 66° F. at the same place; and in a nearly straight course from this point to 10° south, 120° west, found the sea-temperatures successively, 68°, 70°, 70½° 72½°, 73½°, 74°; and beyond this, 75½°, 76½°, 77½° F., the last on November 8, in 14° 24′ south, 136° 51′ west. These observations give a wide sweep to the cold waters of the colder seasons, and throw the isocrymes of 74° and 68° F., far west of the Gallapagos. Captain Wilkes, in passing directly west from Callao, found a temperature of 68° F., in longitude 85° west; 70° F., in 95° west; and 74° F., in 102° to 108° west. These and other observations lead to the positions of the isocrymes of 74°, 68°, and 62°, given on the Chart. The line of 74° passes close by Tahiti and Tongatabu, and crossing New Caledonia, reaches Australia in latitude 25° S.

In mid-ocean there is a bend in all the southern isocrymes.*

Isocrymes of 56° *and* 50° F.—The temperature at Callao, in July, averages 58½° or 59° F. At Iquique, near 20° south, Fitzroy had 58° to 60° F., on July 14, 1835; and off Copiapo, in the same month, 56½° F. At Valparaiso, Captain Wilkes found a sea-temperature of 52½° F., in May; and Fitzroy, in September, occasionally obtained 48° F., but generally 52° to 53°. Off Chiloe, Fitzroy found the temperature 48° to 51½° in July.

Indian Ocean.—*Isocrymes of* 74° *and* 68° F.—Off the south extremity of Madagascar, in 27° 33′ south, 47° 17′ east, on August 4th, Vaillant found the temperature 69·26° F.; and in 29° 34′ south, 46° 46′ east, the temperature of 67·84° F.; off South Africa, August 12, in 34° 42′ south, 27° 25′ east, the temperature 63·5° F.; on August 14, in 35° 41′ south, 22° 34′ east, a temperature of 63·3° F.; while off Cape Town, two hundred miles to the west, the temperature was 50° to 54° F.

In the above review, we have mentioned only a few of the observations which have been used in laying down the lines, having selected those which bear directly on some positions of special interest, as regards geographical distribution.

The Chart also contains the *heat-equator*,—a line drawn through the positions of greatest heat over the oceans. It is a shifting line, varying with the seasons, and hence, there is some difficulty in fixing upon a course for it. We have followed mainly the Chart of Berghaus. But we have found it necessary to give it a much more northern latitude in the western Pacific, and also a flexure in the western Atlantic, both due to the currents from the south that flow up the southern continents.

Vaillant passing from Guayaquil to the Sandwich Islands, found the temperature, after passing the equator, slowly increase,

* See Observations by W. C. Cunningham, Am. J. Sci., [2] xv, 66.

from 76° F., August 19, in 2° 39′ north, 91° 58′ west (of Greenwich), to 81·9° F., in August 31, 11° 15′ north, 107° 3′ west, after which it was not above 80° F. The same place in the ocean which gave Vaillant 76° F., in August, afforded Fitzroy (4° north, 96° west), on March 26 (when the sun had long been far north), 82½° F. This fact shows the variations of temperature that take place with the change of season.

(To be continued.)

Art. XVII.—*Contributions to Mineralogy;* by Dr. F. A. Genth of Philadelphia.

(Concluded from p. 86.)

5. *Owenite*, a new mineral.—I found this mineral in the metamorphic rocks on both sides of the Potomac River near Harpers Ferry, associated with quartz and sometimes with impressions of carbonate of magnesia.

Massive, aggregate of minute scales: cleavage distinct in one direction; H. =2·5; Sp. gr. =3·197 (at 20° C.); color olive-green; streak paler; lustre pearly; fracture subconchoidal; very tough; powder greasy to the touch; odor argillaceous.

BB. fuses easily =3, and gives an iron black magnetic globule; with borax gives the reactions of iron, and with soda in the oxydating flame shows the presence of a trace of manganese. Yields water in the matrass. Dissolves readily in dilute hydrochloric acid.

It was analyzed under my immediate supervision by Mr. Peter Keyser, who obtained the following results.

I. 1·8920 grammes ignited for about forty-five minutes at a bright red heat in a well covered platinum crucible, lost 0·2050 grs.

II. 1·1542 grs. treated in the same manner, lost 0·1195 grs.

It is possible, that these determinations of water are a little too low, because a small quantity of iron was found to have oxydized higher on heating.

III. 2·0770 grs. were dissolved in hydrochloric acid. The silicic acid gelatinized on evaporation: it was evaporated to dryness, the dry mass moistened with hydrochloric acid, diluted with water and filtered after it had completely settled. The silicic acid weighed 0·4798 grs.

The filtrate was oxydized by nitric acid, precipitated by ammonia, redissolved in acetic acid and evaporated in a water-bath, again moistened with water and this often repeated, until all the acetates of alumina and iron were thus decomposed. Both were filtered, and alumina separated from the sesquioxyd of iron by caustic potash in the usual manner. From the acidulated potash solution the alumina was precipitated by sulphid of ammonium; it gave 0·3226 grammes.

The sesquioxyd of iron was redissolved in hydrochloric acid and precipitated by ammonia; it weighed 1·0865 grs.

From the soluble acetates, to which chlorid of ammonium had been added, the lime was precipitated as oxalate, which yielded 0·0106 grs. carbonate of lime.

The filtrate was evaporated to dryness and the magnesia separated from the alkalies by oxyd of mercury; the magnesia was redissolved and precipitated with all the requisite precautions as phosphate of magnesia and ammonia, which gave 0·0670 grs. pyrophosphate of magnesia.

The mixed chlorids of sodium and potassium weighed 0·0185 grs. and the platinum 0·0033 grs.

IV. 1·3668 grs. dissolved and the silica separated as in III, gave 0·3187 grs. silicic acid. From the filtrate, oxydized by nitric acid, both sesquioxyd of iron and alumina were precipitated by ammonia, and the alumina separated from sesquioxyd of iron as above; it weighed 0·2138 grs. The sesquioxyd of iron redissolved and precipitated by ammonia was 0·7148 grs. The filtrate from the sesquioxyd of iron was added to the liquid containing lime and magnesia, and after being concentrated by evaporation was precipitated by oxalate of ammonia. The oxalate gave 0·0100 grs. carbonate of lime.

The magnesia was precipitated from the filtrate by phosphate of soda, and gave 0·495 grs. of pyrophosphate of magnesia.

V. 1·2898 grs. were dissolved in a flask, from which all the air had been displaced by carbonic acid, and the apparatus cooled, while a constant current of carbonic acid passed through it in order to prevent an oxydation of the oxyd into sesquioxyd of iron; then an excess of terchlorid of gold and sodium was added through a tube; the apparatus filled with carbonic acid was allowed to stand twenty-four hours and then filtered. The reduced gold weighed 0·4056 grs.

These results give the composition of Owenite as follows:

	I, III and V.	II, IV and V.	Mean.			
SiO_2	23·10	23·32	23·21	contains oxygen =	12·05	
Fe_2O_3	13·90	13·88	13·89	"	4·16	11·45
Al_2O_3	15·53	15·64	15·59	"	7·29	
FeO	34·58	34·58	34·58	"	7·68	
MnO	*trace*	——	——	"	——	
MgO	1·16	1·37	1·26	"	0·49	8·39
CaO	0·29	0·43	0·36	"	0·10	
NaO	0·41	0·41	0·41	"	0·11	
KO	0·08	0·08	0·08	"	0·01	
HO	10·84	10·35	10·59	"	9.42	
	99·89	100·06				

The ratio of oxygen of $RO : R_2O_3 : SiO_3 : HO$ is,

8·39 : 11·45 : 12·05 : 9·42 or very near

1 : 1·5 : 1·5 : 1

corresponding with the formula $2(3RO, SiO_3)+(3R_2O_3, SiO_3)+6HO$.

Owenite is closely allied to some other minerals, viz., Aphrosiderite and Thuringite, and they all resemble each other so very much that their difference can be detected only by a chemical examination. Aphrosiderite is a mineral not generally known, found at several localities in Nassau, and distinguished from earthy chlorite by Fridolin Sandberger, who gave an analysis of it in his "Uebersicht der geologischen Verhältnisse des Herzogthums Nassau," but without calculating its formula. He found that it contains:

SiO_3	= 26·45	which contains oxygen	13·73	
Al_2O_3	= 21·25	"	9·93	
FeO	= 44·24	"	9·82	10·23
MgO	= 1·06	"	0·41	
HO	= 7·74	"	6·88	
	100·74			

The ratio of oxygen of $RO : Al_2O_3 : SiO_3 : HO$ is

10·23 : 9·93 : 13·73 : 6·88 or very near
1·5 : 1·5 : 2 : 1

which corresponds with the formula $3(3RO, SiO_3)+(3Al_2O_3, SiO_3)+6HO$.

Breithaupt's thuringite according to an analysis of Rammelsberg. is $3(3RO, SiO_3)+(2Fe_2O_3, SiO_3)+9HO$.

The relation of these three minerals will be seen from the following formulæ:

Owenite = $2(3RO, SiO_3)+(3R_2O_3, SiO_3)+6HO$;
Aphrosiderite = $3(3RO, SiO_3)+(3Al_2O_3, SiO_3)+6HO$;
Thuringite = $3(3RO, SiO_3)+(2Fe_2O_3, SiO_3)+9HO$.

This mineral is named in honor of Dr. David Dale Owen, U. S. Geologist.

6. *Kämmererite—Emerald Nickel.*—A year ago, before I had received my foreign journals, I published two analyses of Kämmererite, and finding these different from Kämmererite and Rhodochrome, I proposed for it the name "Rhodophyllite." On being informed that Dr. J. L. Smith was about making an investigation of the same mineral, I wrote him that the conclusion to which I had arrived, after comparing the results of my analyses and those of Mr. Hermann, was, that Kämmererite and my Rhodophyllite were the same mineral, and requested him to mention it in his paper. This ought to have been sufficient. Notwithstanding, an indirect criticism of my analyses by Mr. Garrett, based upon *one* analysis, made by him, has since appeared in the May number of the Journal of Science. Mr. Garrett condemns

my analyses by saying, that Mr. Hermann's, with which mine agree a great deal better than with his, are "unquestionably erroneous." If Mr. Garrett had taken the trouble to give the details of his results, it would then be much easier to find out where the blunder lies. Unfortunately he has not done so, and therefore I am compelled to believe that I am right, since I know that all pains were taken to analyze most carefully a pure mineral, and my analyses agree well with each other.

With reference to his article on emerald-nickel, it suffices to say, that I have described the mineral in 1851 under the name Nickelgymnite.* It is a variety of gymnite in which a variable quantity of magnesia is substituted by nickel, and when pure, it does not contain a trace of carbonic acid. Mr. Garrett would not have arrived at such a scientific formula if he had been more careful in selecting his material. The same is to be said of Mr. Hermann's Pennine, which is a mixture of Kämmererite, Dolomite, Nickelgymnite, etc.

Art. XVIII.—*Hassler's Experiments on the Expansion of Water at various temperatures*; by J. H. Alexander, Esq.

The late Mr. Hassler enjoyed, during his life-time, a high reputation: but one founded, it would appear, at least in this country, more upon the prestige of his manifest and presumed moral and intellectual faculties, than upon any just knowledge or estimate of his special achievements in Science or Art. It is true that these faculties were both large and well-defined: and they had a scope for their exhibition, sometimes, more favorable to the interest of the spectator than the ease and comfort of the actor. He was undaunted, diligent, patient, self-reliant: no man feared an adversary less, or loved friends more; sympathetic, too, and (for which credit was not generally given him) tender-hearted; still his stern self-command enabled him for many years to fold his robe with a certain grace over wounds of soul and body, so deep and sore as to have put out of the heads of many others, who yet think themselves strong men, all idea of the dignity of sorrow. Intellectually, also, Nature had been bountiful to him, and under his finely shaped cranium had placed a net-work of brain, active in perception, and of firm retention. All the organism for a Geometer was there; and wit and humor, too, with a spice of dogmatism, that like carbonic acid in certain wines (itself an irrespirable gas) only served to make them more racy and *mantants*. Unfamiliar people were apt to suppose that

* Keller-Tiedemann's Nordamerikanischer Monatsbericht, Nov., 1851.

this free acidity predominated, normally; but the fact was, that his dogmatism arose out of his disgust at all pretence, and it was always manifested in proportion to the difference between the reality and the pretension in any person or thing that exhibited the latter. He was essentially a man of truth: assumption of any kind disgusted him; while to assumption without a basis (or what is commonly called humbug) he was never merciful, but visited it with all the weight of logic and the sharpness of sarcasm. Those who knew him, knew that he could be both heavy and sharp.

But to draw traits of character was by no means the object of this memoir; what has been said, has slipped from my pen spontaneously. It is true, that honored by the intimacy of Mr. Hassler, and even bound by a sort of half promise (for in the mathematical probabilities of life, there was every chance of my being long his survivor) I should years since, had the means been at my disposal, have endeavored to do justice to his memory by an account of the events he had mixed in, of the services he had rendered towards the stabilitation and diffusion of knowledge, and of the methods which he partly originated. and partly combined, for divers researches of science.

But the present notice of one of these methods, and of its successful employment in the determination of a set of physical constants, is owing to no such editorial impulse. The fact is, that having occasion, in behalf of professional investigations in which I was concerned, to wish for a better tabulated statement of the specific gravity of water at various temperatures than any of those which were accessible to me, it came into my head to examine, reduce, and compare the quite extensive series of observations on this point which Mr. Hassler had made, the apparatus for which I had frequently seen, and the making out of the final results of which had been postponed as I knew, until a more favorable opportunity for their augmentation and extension. These observations, to the number of two hundred and more, were published in 1832 in a Congressional document.* being a report to the Treasury Department on the Comparison of Weights and Measures, where also the description and drawings of the peculiar apparatus is given. As it is no wise necessary to repeat here what is in print elsewhere, this reference will be sufficient. Only these particulars may be noted. viz: 1st. that the quantity of water operated upon, upwards of 30 avoirdupois pounds, was such as vastly to magnify the differences, and reduce the errors of observation; 2nd, that the extent of observation. going as far as the variation of temperature in a whole year, and always allowing the temperatures to settle themselves by their natural tendency in a

* Twenty-second Congress, 1st Sess. H. R., No. 279

room set apart for the purpose, instead of being forced, unstable and therefore doubtful, as in all cases of production of artificial transient temperatures, is such as to afford a more than usual check upon the accuracy of any part of it, and a more than usual confidence in the equilibrium of the temperatures averred.

In this method of observation, it follows that the actual temperatures and the corresponding weights succeed one another irregularly. The first thing to be done, then, was to group the resulting weights, degree by degree, and thus prepare them for their arithmetical means. Their preparation resulted in a synoptical table, in which the average weights corresponding to fractions of almost every degree of Fahrenheit between 35° and 86° found a place. This synopsis was then converted into another, where the temperature was given in whole degrees, and the weights corresponding found by taking proportional parts of the actual weights observed for the said fractions. Then, in order to cover the irregularities of result existing as between degree and degree, and to ensure a sufficient generalization, these last ascertained weights were tabulated from five to five degrees, commencing with 40°, which is so near the density of maximum density as to allow of being assumed for it. In fact, the actual difference of weight observed between 39°·4 and 40°·4 is only 2·4 grains on a weight of nearly 2:8000 grains, or somewhat more than the $\frac{1}{100000}$ part.

The differences of the weights in this last tabulation, divided by 5, and thus reduced to a rate per degree for every five degrees, presented a quite harmonious diverging series; the second differences were nearly constant, and the *plus* and *minus* third differences almost exactly balanced. The mean of these second differences was then taken as a constant; and a new series constructed, which starting from the actual weight found at 40° F., was duly applied at every five degrees to give a new set of *calculated* weights for the respective epochs of temperature. How nearly the two sets of weights agree, will be seen in the following table:

Temperature.	Weights calculated.	Weights observed.	Proportional Differences.
40°	227843·3	227843·3	0· –
45°	837·3	837·3	0· –
50°	811·3	815·4	−0·000014
55°	765·3	766·–	−0·000003
60°	699·3	695·3	+0·000018
65°	613·3	604·3	+0·000040
70°	507·3	501·8	+0·000024
75°	381·3	371·5	+0·000043
80°	235·3	230·5	+0·000021
85°	227069·3	227076·5	−0·000032

What remained, then, was to convert the said calculated weights into decimal parts of unity taken as the maximum density of

water and so occurring as beforesaid at 40° F. Finally, the densities were interpolated from degree to degree between these epochs, according to a method which I have given in a former volume of this Journal.

The final results are given in the following

Table of the Specific Gravities of Water at successive Temperatures of Fahrenheit's Thermometer.

Temp. F.	Specific Gravity.	Temp. F.	Specific Gravity.
40°	1·	63	0·9991523
41	9·9999997	64	0·9990732
42	0·9999978	65	0·9989905
43	0·9999948	66	0·9989043
44	0·9999860	67	0·9988147
45	0·9999737	68	0·9987217
46	0·9999579	69	0·9986252
47	0·9999385	70	0·9985253
48	0·9999157	71	0·9984219
49	0·9998893	72	0·9983149
50	0·9998595	73	0·9982043
51	0·9998262	74	0·9980901
52	0·9997894	75	0·9979723
53	0·9997491	76	0·9978510
54	0·9997052	77	0·9977263
55	0·9996577	78	0·9975981
56	0·9996067	79	0·9974665
57	0·9995522	80	0·9973315
58	0·9994942	81	0·9971929
59	0·9994328	82	0·9970507
60	0·9993680	83	0·9969049
61	0·9992997	84	0·9967555
62	0·9992278	85	0·9966025

Empirical Formula :—

t° = observed temperature ∴

Sp. Gr. at $t^\circ = (69 + 35{\cdot}15\,.\,\overline{t^\circ - 42^\circ})\,\frac{t^\circ - 42^\circ}{2}$.

Art. XIX.—*Biography of Berzelius*; by Prof. H. Rose, of Berlin.

(Continued from p. 15.)

Previous to Berzelius, Dalton, in his new System of Chemical Philosophy, had attempted to express numerically the relative quantities in which bodies generally combine, and by this means, as he regarded bodies as consisting of atoms, he sought to establish as it were the relative weights of the ultimate atoms. Thus originated the doctrine of the so-called atomic weights.

To Dalton, therefore, belongs the great merit of having given the correct idea of that which is now universally called atom in chemistry. Richter had previously employed in a similar sense the name relative mass (massentheil), in order to express the different quantities of acid and base which combine together forming salts; his idea however, was not so material as that of Dalton, and this character was necessary to give it that perfect clearness, which was indispensable, if a theory was to be founded upon it. The long and obstinate opposition which was made by German philosophers to the idea of atoms as employed in chemistry, and the war waged with all the weapons of logical acumen against the atomic view of the composition of bodies, for a long time rather obstructed than favored the advancement and spread of the exact sciences, especially that of chemistry. Now that the atomic theory is adopted by all, the use of the word atom is allowed by all in order to explain the facts with ease and simplicity.

Dalton assumed that simple substances combined in equal atoms, and, indeed, atom with atom, when there was only one compound of the two elements; if several, one atom of one substance combined with one, two, three, or more atoms of another. The first conception of these so-called multiple proportions originated properly with Higgins, who made it known as early as 1789, in a work on the subject. But the most important experiments, by which the theory of Dalton was proved, were instituted by Wollaston, who published in the year 1814 his ingenious scale of chemical equivalents.

When the numbers made use of by Dalton are compared with those which Berzelius deduced from his own accurate experiments, differences are found similar to those existing between these latter and those given by Richter. The number of analyses upon which Dalton had founded his arguments was too small, and moreover they had not been executed with very great accuracy.

In the selection of a substance to be taken as unity, so as to make the atomic weights found, comparable with each other, chemists have hesitated between hydrogen and oxygen. Dalton chose hydrogen, and took it as 1, since its atom is the lightest of all the elements. Many chemists followed his example on this account, especially after Prout subsequently had attempted to shew that the atomic weights of all simple bodies were multiples of that of hydrogen. Richter had long before entertained a similar view, inasmuch as he assumed that the equivalents of all bases form an arithmetical, those of acids a geometrical progression. Nevertheless, Berzelius and Wollaston took oxygen as unity, because it was the most widely distributed of all the elements, and

existed in most compound substances. By adopting oxygen as unity, all calculations were greatly simplified. Berzelius took it as 100, Wollaston as 10. Berzelius remained true to his opinion to the last, and always declared himself against that of Prout, even when, in 1840, it was again adopted by Dumas, who attempted to prove its truth for at least a few elements by actual experiment. It is true that the atomic weights of several of the non-metallic elements appear to be multiples of that of hydrogen, but it has not been possible to maintain Prout's views as regards others. So long as we are ignorant whether this correspondence is merely accidental, or actually a law of nature, we must suspend a decision.

In the determination of the number of atoms in compound bodies, Berzelius proceeded with great caution. Dalton and others, who had put forward the view that substances combine especially in such proportions that one atom of one element unites with one atom of another, assumed also that when, for example, several oxyds of an element existed, the oxygen atoms of the higher oxyds were multiples of oxygen in the lowest oxyd. But when only one oxyd was known, it was obviously very hazardous to assume that it consisted of equal atoms of both elements, without taking any notice of the other relations of this compound. Berzelius studied all the circumstances with the greatest attention, and the caution as well as penetrating tact with which he proceeded, are evident from the fact, that, when subsequently, Mitscherlich, by his important discovery of Isomorphism, furnished an admirable means of recognizing with certainty bodies having similar atomic composition, it was not necessary for Berzelius to make any alteration in his views.

Only upon one occasion did he feel himself compelled to modify his views regarding the arrangement of atoms in compound bodies. On the first establishment of his system, he was of opinion that in simple compounds, such as oxyds, there must be the most simple proportion, and the relation of two atoms of the radical to three of oxygen appeared to him to be too complex. Since in the oxyds of iron the oxygen was in proportion of two to three, he assumed that peroxyd of iron consisted of one atom of metal and three atoms of oxygen, the protoxyd and all those similar to it as consisting of one atom of metal and two atoms of oxygen. It was not until later in the year 1827, that Berzelius, particularly influenced by the proportions of the elements in the oxyds of manganese, chromium, and sulphur, decided upon assuming, that, in the strongly basic or so-called electro-positive oxyds, there was but one atom of metal and one atom of oxygen, and, consequently, that the atomic weights formerly adopted by him must be reduced to one-half. The higher oxyds, such as peroxyd of

iron, would then contain three atoms of oxygen to two atoms of metal.

At that time, Berzelius adopted the view, that when a simple body is converted into the gaseous state, one volume of the gas corresponds to an atom. For this reason, water was always regarded by him as composed of one atom of oxygen and two atoms of hydrogen. He held this opinion firmly, and disputed the hypotheses of Thomson, Dalton, and other chemists, who assumed that in two volumes of hydrogen there were as many atoms as in one volume of oxygen. Subsequently, when by the direct determination of the specific weights of sulphur, phosphorus, and mercury vapors, made by Dumas and Mitscherlich, this assumption of Berzelius was not generally confirmed, he limited its application to the permanent gases alone.

He was on this account compelled frequently to assume two atoms where other chemists assumed only one atom. He therefore introduced double atoms in those cases where they were the equivalent for one atom of another substance. Many chemists especially in Germany, have not followed this view; and Leop. Gmelin, in the last edition of his "*Handbuch*," as well as Liebig and his followers, have commenced to take the atomic weights of hydrogen, nitrogen, chlorine, bromine, iodine, fluorine, and phosphorus, as double those adopted by Berzelius; many French chemists also entertain this view. The assumption that the so-called equivalents are identical in meaning with the term atoms, has indeed so much probability, that the agreement of so many chemists in this respect cannot be remarkable.

Notwithstanding this, Berzelius continued to the last to adhere to his old atomic weights, and the reasons which, in the last edition of his *Lehrbuch*, he has assigned for doing this, are so strong, that they cannot well be set aside. These he derives especially from the isomorphism of perchlorates and permanganates as proved by Mitscherlich, and from which it follows that a double atom of chlorine can replace a double atom of manganese. Since, however, manganese is in its compounds isomorphous with iron and chromium, (for instance, in the alums,) and since chromium in chromates has the same form as sulphates, a simple atom of chlorine must be able to replace an atom of sulphur. But if perchloric acid consists of a double atom of chlorine, combined with seven atoms of oxygen, then the hypochlorous acid contains only one atom of oxygen, combined with the same quantity of chlorine as in the perchloric; and as hypochlorous acid consists of two volumes of chlorine and one volume of oxygen, the volumes of the two elements must correspond with the simple atoms. Moreover, since it appears to have been proved, by often-repeated experiments with organic bodies, that their hydrogen can be replaced by an equal volume of chlorine, a simple, and not a double, atom

of hydrogen must be able to replace one atom of oxygen or sulphur.

Even if it does sometimes happen that we do not find conclusions of this kind confirmed by experiment, if in the replacement of one body by another in compounds, an element, as for instance potassium, may be replaced by a compound radical such as ammonium, still it is not admissible to assume that such substitutions as may be theoretically inferred from the similarity in atomic weight, or atomic volume, really do take place, without the authority of repeated experiment. It is certainly convenient to regard equivalent and atom as synonymous terms, although not truly appropriate in a scientific view.

For the purpose of expressing the proportions in which bodies combine chemically, Berzelius, so early as the year 1815, employed certain signs as symbols for the different elements. Such signs were employed long before this in chemistry, or rather alchemy, although they were then of little value. These symbols undoubtedly owed their origin to the mysterious relation between the planets and metals, as assumed by the alchemists, and the pleasure which they took in expressing themselves in a manner unintelligible to the people. Berzelius would not adopt the old symbols, not only because they were, in fact, destitute of all significance, but likewise because it is certainly easier to write the abbreviation of a word than to draw a figure. The symbols of Berzelius, however, serve to express the chemical combining proportions, and the chemical formulæ furnish a means of representing the numerical results of an analysis with all the simplicity of an algebraical formula.

The system of symbols introduced by Berzelius has met with such universal recognition, on account of its extraordinary convenience, that there is probably no chemist who does not now employ it; and this renders it the more remarkable, that the opposition made to this innovation was at first so considerable. A French philosopher exchanged the symbols proposed by Berzelius, for the initial letters of the French names for the elements. But it was in England that the greatest opposition was made to the adoption of the chemical formulæ of Berzelius. Even so late as 1822, an English chemist, speaking of them, said, "they are calculated more to produce misunderstanding and mystification than clearness, since they are of a nature totally different from algebraical formulæ; it would be easier to express oneself in ordinary words than with these symbols, which only make a kind of mathematical parade." Berzelius replied to the partly rude and uncourteous objections with dispassionate clearness and composure. Who would now consider it possible to dispense with the use of these "abominable symbols" of Berzelius, as they were

termed by the editor of an English journal? The opposition to the introduction of these symbols was the more remarkable, since Dalton, in putting forward his atomic system in 1808, had felt the urgent necessity of representing the atoms of elements by means of symbols, which did not then meet with any opposition, although at the same time with no imitation in England. The symbols of Dalton are, however, far less appropriate than those of Berzelius; moreover, they sufficed only to express simple combinations, and not very complicated ones. The introduction of Berzelius's symbols first enabled the chemist to construct chemical formulæ.

When Berzelius began to prove the law of chemical proportions by experiment, he was so firmly convinced that in inorganic bodies only the most simple relations obtained, that he even doubted the accuracy of his own experiments, when their results gave complicated relations. It was long before he could allow himself to admit that simple substances could combine with three, five, and seven atoms of oxygen, because these numbers were not multiples of each other. He therefore assumed, that in phosphoric acid there were four atoms of oxygen, in the arsenious and arsenic acid four and six atoms, and in oxide of antimony and antimonic acid the same number; and long after he had convinced himself of the elementary nature of chlorine, he doubted the correct statement of Stadion, that hyperchloric acid contained seven atoms of oxygen.

The examination of the oyxds of nitrogen presented considerable difficulties to him. As ammonia was analogous to the fixed alkalies, and under the influence of galvanic electricity yielded an amalgam with mercury, there was a possibility of assuming that this was a process of reduction, and that ammonia consisted of a metal and oxygen. But when ammonia was decomposed, no oxygen was obtained, but only nitrogen and hydrogen: the oxygen must therefore, Berzelius inferred, be concealed in these gases and one or both must be oxyds of the same radical, and this radical the metal ammonium. But if nitrogen alone were the oxydized body, then the metal ammonium must consist of the radical of nitrogen and hydrogen. Then, again, at that time several chemists, especially Gay-Lussac and Thenard, assumed that potassium and sodium contained hydrogen; however, in the controversy which arose on this point between these chemists and Davy, who sought to disprove their view, Berzelius immediately decided in favor of the latter, and supported him with very strong arguments. He also assumed, on this account, the presence of oxygen in hydrogen, and this, as well as nitrogen, were, according to his view, oxyds of the metal ammonium. The different stages of oxydation were, according to him, the following: hydrogen, pro-

toxyd of ammonium (the present amidogen combined with potassium), ammonia, nitrogen, nitrous acid, nitric acid, and, finally, water, the highest oxyd of the radical, which, however, must, on this view, have contained 72 times as much oxygen as the lowest oxyd hydrogen.

Berzelius was led to adopt this extravagant but ingenious view by too great faith in the doctrine of proportions in the form in which he then conceived it. Somewhat later, he retracted the opinion that hydrogen was an oyxd, and demonstrated the elementary nature of this body by weighty arguments; but he still continued to regard nitrogen as containing oxygen, and endeavored afterwards to prove this by means of its oxyds. Even in 1818, in a paper upon the nature of nitrogen, hydrogen and ammonia, he said, "I venture to assert, that the compound nature of nitrogen must not be regarded as a mere hypothesis, but, if the doctrine of definite proportions is admitted, as a demonstrated truth." He assumed that an unknown radical—nitricum—existed, to which he assigned the symbol N, subsequently retained for nitrogen, which was then regarded as the suboxyd of this supposed radical, and the highest oxyd—nitric acid—as containing six atoms of oxygen.

It was, however, in truth, the circumstance that the proportion of the oxygen in nitrous acid to that in nitric acid was as 3 to 5, which alone misled him so obstinately to assert the existence of oxygen in nitrogen, in which case that proportion would have been as 4 to 6. When a short time afterwards he made his researches on the composition of phosphorus and phosphoric acids, in which he found, almost simultaneously with Dulong, that the quantities of oxygen were in the proportion of 3 to 5, and after having in vain attempted to detect oxygen in phosphorus, his views respecting the compound nature of nitrogen were shaken, and he finally relinquished them, after having convinced himself that a similar relation obtained between very many, we may perhaps now say most, of the different oxyds of simple bodies which form acids. Subsequently, he sometimes made the remark, without, however, assigning any particular importance to it, that from the production of nitrogenious compounds in the organisms of herbivorous animals, whose food frequently appears not to correspond in composition with them, the existence of oxygen in nitrogen might be inferred. However, in the last edition of his "Lehrbuch," even this remark does not occur.

This too great faith in the extreme simplicity of chemical combining proportions induced Berzelius, in some other instances, to assume the existence of oxyds which had no reality. In the investigation of the oxyds of tin, he assumed that the oxyd obtained from the Spiritus Libavii, which certainly differs greatly in its

characters from that obtained by means of nitric acid, was, in reference to the quantity of oxygen which it contained, intermediate between the protoxyd and peroxyd. Shortly afterwards Gay-Lussac shewed that it did not differ from the oxyd prepared with nitric acid in its quantity of oxygen. After Berzelius had convinced himself of the truth of this remark, he showed how much the two differed in their characters. This was the first example of Isomerism.

Berzelius connected the electro-chemical doctrine with that of simple definite proportions. It was very natural that he should apply the phenomena presented by the voltaic pile, and especially the facts which in his first paper he had so convincingly explained, to the ordinary chemical processes. He assumed, that in every chemical process there was a neutralization of the opposite electricities, in consequence of which heat and light were produced in the same way as in the discharge of a Leyden jar, the galvanic battery, or lightning, with the difference, that these phenomena were not always accompanied by chemical combination.

Even at the very first, Berzelius did not conceal from himself the difficulties which this theory involved. He assumed that the atoms possessed electrical polarity, upon which depended the electro-chemical phenomena attending their combination. Thus, the atoms of oxygen were regarded as having a preponderance of negative electricity; those of potassium a preponderance of positive. The unequal intensity of the electrical polarity in the atoms of different bodies, dependent partly upon their temperature, was regarded as the cause of the difference of force with which affinities are exercised. He altered his views of this subject at different times, and finally admitted that it was very possible that he was in error.

In classifying bodies as electro-positive and electro-negative, Berzelius regarded oxygen and the elements resembling it as electro-positive. Subsequently, however, he altered the nomenclature, and more correctly called them electro-negative. Oxygen alone he regarded as absolutely electro-negative, all other bodies being only relatively negative or positive, just as they would be related to each other when their compounds were exposed to the influence of the electric pile.

These views of Berzelius have been frequently disputed. And in truth, the phenomena attending the greater number of ordinary chemical processes, in which bodies act upon each other only when in immediate contact, are different from those which occur during the discharge of an electric pile where bodies act at a distance. It is only in some chemical processes, such as the arborescent deposition of metals, that there is a resemblance to the decompositions effected by the pile.

Much later, Berzelius assumed the existence of another force, although only as regarded some special chemical changes—the catalytic force. The evolution of light and heat, according to the electro-chemical theory, could only result from the combination of bodies opposite in their characters; but when they occur in the decomposition of bodies, or when compounds are decomposed and new ones formed, while at the same time the body whose presence causes this change takes no part in it, Berzelius ascribed this effect to the force of catalysis.

Much has been brought forward in opposition to the assumption of this new hypothetical force. But it is not justly censurable that, in an imperfect science like chemistry, all phenomena which stand isolated, for which no suitable analogues can be found, and which appear as it were wonderful, should provisionally be ascribed to a peculiar cause or force, so as openly to admit, that in the present state of the science it is more appropriate not to explain a chemical process at all, than to do so in a forced and fastidious manner. With the advance of the science, the number of phenomena belonging to such categories will always become smaller.

After Berzelius had labored uninterruptedly during a space of ten years in the investigation of the atomic weights, of the elements and their compounds, and had these so far established that all experiments corresponded to within small and unavoidable errors, he was in a position in 1818 to publish tables containing the atomic weights of about 2000 simple and compound bodies.

Thus had Berzelius completed, as it were, the scaffolding of his system, and he now commenced to supply the deficiences which he had previously been obliged to pass over, and thus to plan out the whole.

Sometime before, in 1814, he had also extended his investigations to organic substances, and published a very important paper on the definite proportion in which the elements are combined in organic nature. He there shewed at length, that however different organic bodies might at first sight appear to be from inorganic, in regard to their elementary composition, still the only certain clue by which we could hope to arrive at a correct conception of the nature of the composition of those bodies which are produced under the influence of vital processes, was what was already known of the composition of inorganic bodies. He had therefore the great merit of having extended the doctrine of the simple chemical proportions in which bodies combine to organic bodies.

The first accurate experiments on the elementary composition of organic bodies had been instituted a few years previous to the appearance of this paper, by Thenard and Gay-Lussac, in 1811. Nevertheless, they contented themselves with drawing no other inference from their results than that a vegetable substance is al-

ways acid when it contains oxygen in a proportion greater than is necessary to form water; that by an excess of hydrogen, resinous, oleaginous, or alcoholic substances were formed; and lastly, that when oxygen and hydrogen were present in the same proportions as in water, these substances were neither acid nor resinous, but analogous to sugar, gum, starch, milk sugar, or woody fibre. These conclusions were correct, only for the substances which they examined, and proved untenable when a greater number had been studied. From the results of their investigation of animal substances, they could not draw even similar inferences; they contented themselves with remarking, that they contained a greater quantity of hydrogen than was necessary to form water with the oxygen present, and that it was united with nitrogen in the form of ammonia.

Gay-Lussac and Thenard had burnt the organic substances by means of chlorate of potash, in a special form of apparatus; Berzelius borrowed from them the use of chlorate of potash, but his mode of combustion was incomparably more advantageous. He had already become convinced that it was necessary to estimate the carbonic acid obtained by its weight, and not by the volume. This was not always observed afterwards, on which account the analysis of organic bodies did not yield accurate results until a few years since, when Liebig introduced the extremely advantageous potash apparatus, which rendered it possible to weigh the carbonic acid with accuracy. Moreover, Berzelius estimated the hydrogen, not in the indirect way, like Gay-Lussac and Thenard, but he weighed it directly after it had been converted into water, which gave the results of his investigations a far greater accuracy in respect to this element.

The number of organic substances investigated by Berzelius was not very great, because the construction of apparatus, and the novelty of the subject presented many difficulties. But although afterwards the methods of analysis were greatly simplified and improved, still the analytical results obtained by him in his investigation of organic substances have proved to be remarkably accurate.

He shewed that, not only the organic acid, but also the indifferent substances, combined with inorganic oxyds in definite proportions, forming compounds resembling salts, by means of which their atomic weights could be determined, as in the case of inorganic bodies. This observation led to the view which regards organic bodies as oxyds, whose radicals, however, are compound, while in the inorganic bodies they are simple. This view at first attracted little notice among chemists, and was not till long afterwards recognized as correct by many, after the number of fantastic ideas of the composition of organic bodies had created an earnest desire for a rational and consistent theory.

It is a subject of regret, that it was not granted to Berzelius to live to see several of the radicals hypothetically assumed by him, actually obtained, as was done indeed but a very short time after his death.

Soon after the establishment of the electro-chemical system, Berzelius applied the theory of chemical proportions to minerals, and put forward a mineral system, based upon chemical principles. If the minerals occurring in nature are regarded as having compositions similar to the substances artificially prepared in the laboratory, such a mineral system is, indeed, very appropriate. Every man of science must, however, admit that in this case a different system of classification must come into use in Mineralogy from that adopted in Botany and Zoology. The inorganic substances with which that science has to do consist of a large number —more than 60—simple bodies: the organic substances, on the contrary, of very few—only three or four. Since, moreover, the intimate connection existing between the chemical composition and all the external characters of minerals cannot be detected, it is obvious that minerals might be more easily and certainly recognized, distinguished and classified, as soon as their chemical composition was studied; but not so plants and animals, in the case of which we do not yet know that there is such an intimate connection, and which, notwithstanding the greatest diversity in form, have almost all the same composition. Were it possible, likewise, to recognize their species by means of an easy chemical analysis, we should call every botanist and zoologist one-sided who neglected to avail himself of this means of recognition.

Before Berzelius's time, it had often been attempted to classify minerals according to their constituents, but before the doctrine of definite proportions, and the correct views of the composition of bodies were known, this could only be imperfectly effected. Such systems were those which Karsten had put forward in his mineralogical tables, and Hauy, in his mineralogy: but the achievements of Berzelius in this respect, caused the attempts of his predecessors to be entirely forgotten.

The mineral system put forward by Berzelius met with opposition, especially from those who followed the so-called natural systems.

In the natural systems of mineralogy, the minerals are all placed according to their similarity in external characters. But all these differed from each other, because they were constructed in accordance with subjective principles.

Werner had, in addition, based his natural system, to a certain extent, upon chemical principles, which were not carried out very consistently, as indeed was impossible, considering the state in which the science then was. But Mohs put forward the fundamental principle, that mineralogists should only pay attention to

the natural history characters of minerals, such as crystalline form, hardness, specific gravity, and not to such as cannot be observed without causing a sensible alteration in the substance. If it ever happens,—continues Mohs,—that a branch of natural history as mineralogy, employs such characters in its method as these last mentioned, it then exceeds its legitimate bounds, becomes entangled with other sciences, and hampered with all those difficulties of which mineralogy has long been a warning example.

Berzelius criticised this argument with justice. He declared that it seemed to him the same as if a man who is stumbling in the dark, should hesitate to make use of a light, because he would then see more than he required, and because he hoped to find his way without it.

In order to appreciate fully the great merit of Berzelius, in putting forward his mineral system, it is only necessary to call to mind how great was the chaos in mineralogy before his time, and especially with regard to the classification of the numerous compounds of silica. Although both Döbereiner and Smithson commenced to regard silica as an acid, at about the same time as Berzelius, still it was he who first made an extended application of this view, in the new mineral system which he proposed, by means of which siliceous minerals were included under the head of saline compounds, and the correct conception of their composition first rendered possible.

The greater number of natural compounds of silica are double salts; and observing the great diversity among them, Berzelius raised the question, as to whether it was probable that the individual members of such double salts were different stages of saturation. As he had previously assumed only the most simple relations in chemical compounds, he was at first led to infer upon theoretical grounds, that the existence of dissimilar stages of saturation in the double salts of silica, was less probable, especially as he had never met with any similar phenomena in his investigations of the double salts of other acids. Nevertheless, he subsequently altered this view, after he had himself first prepared the remarkable double salt of neutral carbonate of magnesia, and bicarbonate of potash.

The salts of silicic acid, and indeed all true compounds occurring in natural as well as artificially prepared salts, received formulæ which expressed their composition. But as Berzelius was long doubtful how many atoms of oxygen he should assume in silica, and even when he afterwards decided for three atoms, did not regard this assumption as perfectly certain, he introduced more simple formulæ for siliceous compounds, which he termed mineralogical, and distinguished from the chemical formulæ by the printers' type employed.

The establishment of correct formulæ, especially for siliceous compounds, involved great difficulties, since the composition of very few minerals was known with any degree of certainty. The first quantitative analyses of minerals were made by Torbern Bergman, but according to such imperfect methods, that they scarcely indicated anything more than the qualitative composition. After these came the analyses of Klaproth, which compared with those of Bergman were a considerable and encouraging advance, for he had not only employed better methods of investigation, but also worked with much greater accuracy. But even the analyses of Klaproth as well as those of Vauquelin and others, who worked simultaneously with him, when put to the test of definite chemical proportions, were not found to be unquestionable. It is true, that at first Berzelius could very often only propose a conjectural formula for the composition of many minerals, and generally only after making slight alterations in the results of the then known analyses, in doing which, however, he always proceeded with great caution. Afterwards these incorrect analyses were replaced by correct ones, and especially by Berzelius himself and his pupils, who employed in their analyses the most accurate methods proposed by him.

Berzelius first arranged minerals according to their electro-positive constituents. But after Mitscherlich's discovery of isomorphism, which has exerted so important an influence upon the arrangement of the system, he considered it more advantageous to classify minerals according to their electro-negative constituents, because the substitution of isomophous substances is far more frequent among the bases than among the acids; and therefore the classification according to the electro-negative constituents corresponded more with the requirements of mineralogists. Both methods have their advantages: they are equally philosophical, and may be employed with equal justice; it was therefore with great injustice that Berzelius was charged with inconsistency in making this alteration.

The mineral system of Berzelius is not even yet completed. He was far from wishing to affirm that it was incapable of improvement; on the other hand, during his whole after-life he continually improved it, and from time to time published it in a more perfect form. The last edition was superintended by Rammelsberg, in 1847, at the request of Berzelius.

The most important modifications still to be made on this system, are perhaps those which would result from a simple application of the doctrine of isomorphism. It is certainly difficult to harmonize the opinions as to the best method of doing this.

Berzelius was not quite right in affirming that the constituents of a substance alone must determine its place in a system. Even in the last "*Jahresberichte*" published by him, he

declares that, in a mineral system, the sole question for consideration is the elements and their inorganic combinations, and that it is these which must be systematically arranged. But he himself directs attention to the difficulties which this view necessarily involves. Is it, he asks, admissible to make one species of diamond and graphite, or of rutile, brookite, and anatase, or of calcareous spar and arragonite? It is scarcely to be expected that mineralogists will give their consent to such a course.

However, Berzelius decides in the affirmative. Still I am of opinion that there are even many chemists who will not unconditionally agree with him in this. For it is not alone from the constituents that all the characteristic properties of the compound result, but also from the mode and action of their combination, which is frequently indicated by the form. Taking all this into consideration, it appears probable that dolomite is more closely related to calcareous spar than arragonite, and even that tinstone is nearer to rutile than anatase and Brookite.

Since the external characters of minerals are determined, as well by their constituents as by the mode in which these are combined with each other, it follows that that chemical system of mineralogy which approaches most closely to the natural systems, or which even corresponds with them, must be the most perfect.

(*To be continued.*)

Art. XX.—*Artificial Formation of Minerals*; by N. S. Manross.

[This memoir—an inaugural dissertation by Mr. Manross on his promotion to the rank of Doctor of Philosophy at the Georgia-Augusta University (32 pp., 8vo, Göttingen, 1852)—contains an account of the artificial formation of several minerals. The experiments were made in the Laboratory of Prof. Wöhler. We cite briefly the processes followed by Dr. Manross and his results.]

Heavy Spar ($\dot{B}a\ddot{S}$) was obtained by fusing together twelve grammes of neutral sulphate of potash and 52 grammes of anhydrous chlorid of barium in a thin porcelain crucible, this being enclosed in a Hessian crucible which was well luted. After an hour, on treating the cooled mass with water, an abundance of minute crystals were left behind which had the form of heavy spar, giving M : M = 101° 43′. Some of them were two millimetres long and one thick. Analysis afforded $\ddot{S}$ 34·32, Ba 65·57, = 99·89.

Celestine ($\dot{S}r\ddot{S}$) was formed by fusing together sulphate of potash with an excess of chlorid of strontium. On breaking open the cooled mass many transparent crystals were seen. They were separated as before by dissolving the excess of chlorid in

water. The largest were two to three mm. long, but these were uneven. The smaller were brilliant and perfect. The crystals were usually elongated in the direction of the shorter diagonal, M : M = 104° 11′. There were many compound crystals crossing at angles nearly of 41°, and also six-rayed stars. There were also cruciform crystals, in which each bar was itself a compound crystal, with reëntering angles at the end, and a hopper-shaped cavity at the center of the cross. Analysis afforded the usual constitution.

Anhydrite ($\dot{Ca}\,\ddot{S}$).—Fifteen or twenty grammes of neutral sulphate of potash were fused with four or five times as much chlorid of calcium. The surface of the cake obtained, appeared after cooling, covered with a film of crystalline plates, and on breaking it, there were cavities occupied by groups of rectangular crystals, several millimeters long and two broad, but scarcely thicker than letter paper. Analysis afforded $\dot{Ca}$ 41·44, $\ddot{S}$ 58·50 = 99·94.

Apatite.—Daubrée obtained apatite in microscopic crystals by passing chlorid of phosphorus over caustic lime at a red heat (Comptes Rendus, xxxii, 615). Dr. Manross fused phosphate of soda (first rendered anhydrous) with an excess of a mixture of chlorid of calcium and finely powdered fluor spar. The resulting mass was full of slender transparent hexagonal prisms, sometimes a millimeter long, many of which ended in a pyramid formed on the angles; angle over the summit 68° 15′—which is the angle of one of the pyramids that occurs in apatite. No analysis could be made on account of the difficulty of separating the crystals from the fluor spar.

In another trial, phosphate of soda was fused with fluor spar and slender six-sided needles were obtained.

In a third, 10 grammes of phosphate of soda were fused with 50 of chlorid of calcium. The crystals thus obtained were hexagonal, usually terminated by pyramids, a face of which made with a prismatic plane the angle 129° 7′, which differs more than a degree from the angle of apatite. G. = 3·054. Analysis afforded Cl 13·02, Ca 7·36, $\dot{Ca}^3\ddot{P}$ 79·10 = 99·48, which requires the formula $3\dot{Ca}^3\ddot{P} + 2CaCl$.

Pyromorphite ($3\dot{Pb}^3\ddot{P} + PbCl$).—Ten grammes of tribasic phosphate of soda were fused with 70 grammes of chlorid of lead. While the temperature was still above the fusing point of chlorid of lead the fluid contents were poured out, and the interior was found to be lined with light yellow transparent and brilliant hexagonal prisms, three to five mm. long, terminating in pyramids; angle between the pyramidal planes and the prismatic 130° 23′, which is within 1′ of the angle given for pyromorphite. G. = 7·008. Analysis confirmed the result.

Wolfram ($(\dot{Fe}, \dot{Mn})\ddot{W}$).—Finely powdered native wolfram may be recrystallized by fusing with a considerable quantity of chlorid of sodium. The heat applied was such as to evaporate

most of the chlorid. The mineral formed a dark stratum in the bottom of the crucible, and the crystals were in brilliant grains and beaded crystals, not admitting of measurement.

Tungsten (Ca Ẅ).—Neutral tungstate of soda was fused with an excess of pure chlorid of calcium in a Hessian crucible. After a strong heat for half an hour, it was allowed to cool gradually. White glittering grains were obtained which were unmodified square octahedrons; angle over a basal edge 130° 20′. G.= 6·0759. In one case when the heat applied was rather low and the cooling somewhat rapid, the tungsten was in the form of needles, each needle being made up of a series of octahedrons, 44 of which were counted in one needle. Analyses gave Ẅ 80·42, Ca 19·58.

Scheeletine (Ṗb Ẅ).—Ten grammes of tungstate of soda were fused with 47 of chlorid of lead. In the dark green mass there were cavities lined with brilliant crystals which were square octahedrons; angle over a terminal edge, 99° 46′. There were planes of another octahedron at the summits. G.=8·232 and 8·238. Composition Ṗb 46·65, Ẅ 53·35.

Wulfenite (Ṗb M̈o).—Hausmann has described this mineral as occurring in the walls of a furnace at Bleiberg in Carinthia. (Ann. Ch. u. Pharm., lxxxi, 224). Four grammes of neutral molybdate of soda were fused with 24 of chlorid of lead. The crystals obtained appeared like hexagonal plates with unequal angles. They were pale yellow, and some of them more than two millimeters across. On dissolving the excess of chlorid of lead, square octahedrons were found, many of which were tabular by the enlargement of two opposite faces. Angle over a terminal edge 99° 43′. G.=6·811. Analysis gave 60·59 p. c. of lead.

Crocoisite (Ṗb C̈r).—In the first trials the heat was too high and the chromic acid was mostly reduced to oxyd. In another trial transparent crystals were formed, having the color of the native chromate. G.=6·118. Streak orange-yellow. Analysis C̈r 32·763 Ṗb 67·239=100·002.

Anglesite (Ṗb S̈).—By fusing together neutral sulphate of potash and an excess of chlorid of lead, crystals were obtained which had the tabular form and many of the modifications of sulphate of lead. As the result was not quite satisfactory, a more successful trial was made in the wet way.

A solution of sulphate of potash was prepared, forming a stratum an inch deep in a tall beaker glass. Several inches of pure water were carefully filtered upon this stratum so as to leave it undisturbed. A few grammes of chlorid of lead were fused to a cake and suspended by a platinum wire, just within the surface of the fluid. It was then set aside for some weeks. At first a white cloud was formed when the stream of dissolved chlorid reached the solution of sulphate below. But as the latter became diffused through the fluid, the cake of chlorid, and even

the platinum wire, became covered with a growth of tabular crystals. Some of them attained a length of from one to two millimeters in the course of three weeks. The sides of the glass were also covered with brilliant crystals, but only above the zone first occupied by the solution of sulphate. A considerable portion of the chlorid remained undissolved even after several weeks time had elapsed. It would undoubtedly be practicable to obtain crystals of any desirable size by this process.

The form of the crystals was that of an elongated table terminated by faces of the primary octahedron. The angle 0P : P was 115° 32′, agreeing with that of the natural mineral.

Before the blowpipe, the crystals decrepitated strongly and gave with soda the reaction of sulphuric acid, and a globule of lead. No further examination was made of them.

ART. XXI.—*On the Probable number of the Native Indian Population of British America*;* by Capt. J. H. LEFROY, R. A.

THERE are probably few persons who, in the course of their reading in history, have not dwelt with peculiar interest upon the glimpses we catch through the mists of the past, of whole races of men that have vanished from the face of the earth, leaving no heirs or representatives to inherit the richer blessings of our age: of nations whose part in the great drama of human life we can never ascertain, whose sages are forgotten, whose warriors lie with "the mighty that were before Agamemnon" in the obscurity of oblivion. Then we may remember "how small a part of time we share" whose interests are so momentous for eternity; and may recognize, in the force of our sympathy, in the eagerness with which we interrogate the monuments that have descended to us: in the curiosity which all their reserve cannot baffle; a testimony to the truth of the declaration of the sacred historian, that the Creator "hath made of one blood all the nations upon earth;" as well as the tie of relationship which unites all the descendants of our common parents, whatever their place in the stream, or their fortunes on the stage of life.

Naturalists have been able to number some half-dozen birds or animals that have become totally extinct within the period of authentic history. We have lately seen what general rejoicing the discovery of a living specimen of one previously ranked in that number (the *Apteryx*) has created among them. The skull, the foot, and a few rude pictures of the Dodo, have furnished ample material for a quarto volume. How many might be written on

* From the Proceedings of the Canadian Institute.

the varieties of the human race that have ceased to exist within the same period! The Dodo was very common at the Isles de Bourbon two centuries ago; it was neglected, hunted down, and finally exterminated: and the Dutch seamen who made an easy prey of whole flocks, twenty or thirty at a time, in 1602, (the Dodo, page 15,) no more suspected that we should now be ransacking all the museums of Europe for scraps to elucidate its affinities, than the first settlers of Newfoundland did that we should also be seeking in vain for one relic of its aborigines. When happy and hospitable crowds welcomed the Spaniards to the shores of Hispaniola, those cavaliers little dreamt that in three centuries or less the numerous and warlike Caribs of that Island, like the Gauchos of the Canaries, would be extinct, as completely so as the Architects of the Cyclopian remains of Italy, or the race that preceded Saxon, and Dane, and Celt, in the occupation of the British Isles. In half a century there will be no trace of a native race in some of the British colonies in the east. The natives of Van Diemens Land, for example, who numbered 210 in 1835, were reduced to 38 in 1848.* It even appears doubtful whether that most interesting of all savage races, the Maoris of New Zealand, with its wonderful force of character, and faculty for civilization, will not die out faster than it can conform to its altered condition. Like those silent yet ceaseless operations of nature, which are wearing down, while we speak, the solid matter of every mountain chain, and substituting the luxuriant vegetation of the tropical coral reef for the barren waste of the sea: so, slowly and imperceptibly, are the great changes effected, by which one race supersedes another in the occupation of portion after portion of the globe, bringing higher qualities, a different moral and physical organization, to work out higher destinies, and fulfill higher ends of the same controlling Providence.

These reflections have been suggested by the subject of the paper which I now propose to lay before this Society, containing the result of some enquiries I have made with a view to forming something like an authentic estimate of the number of the Indian race inhabiting the British possessions in America:—a portion only, it is true, of the whole race, yet one which by reason of the great extent of those possessions, is commonly regarded as a very important one. If, as I think it can be shown, that number is vastly smaller than most persons would suppose, and very rapidly diminishing, under circumstances which are nevertheless by no means unfavorable to its preservation; then it must be admitted that the prospects for the race at large are anything but encouraging: that the time may not be far remote when posterity may be counting its last remnants, and wishing that we in our day had been more alive to the facts, and more industrious in setting up

* Our Antipodes, by Colonel G. Mundy, 1852, vol. ii.

marks by which they might measure the ebbing tide, and comprehend the destiny about to be consummated.

What constitutes density of population, is a question not easy to answer, when it relates to civilized communities, so wonderfully has Providence ordained that with fresh demands, and the heavier pressure of necessity, fresh resources should be found in nature for human sustenance; but in reference to uncivilized man, linked to nature by stronger ties, and having his existence bound up, as it were, with those of her provisions which do not greatly vary from age to age, and are not so beyond our means of estimation, it does not seem impossible to assign limits beyond which his numbers can never far extend, and within which there is no reason that they should much vary, unless by the operation of external causes. However, I have no intention of attempting such an estimate here. We have evidence in the great earthworks of Ohio, requiring an immense number of hands for their construction, that at some period a considerable population occupied the fertile valleys of that region. We know that agricultural pursuits prevailed among many tribes, which have since almost completely abandoned them; but with all this, it is difficult to avoid the conclusion, based on the desolating habits of Indian warfare, on the severity of the climate, and on the degraded position of the female sex, that upon the whole, the population of the middle and northern portion of the continent must, at all times, have been small in proportion to its area, and never on a par with the simplest of all natural resources, the animal life of the region.

The materials for a specific estimate of their numbers at any one early period, are exceedingly scanty. The early travellers dealt in round numbers to an alarming extent. "*Qui dit un Canton d'Iroquois*" says de la Hontan, "*dit un douzaine milliers d'ames. Il s'en est trouve jusqu'a quatorze mille et l'on calculait ce nombre par deux mille Vieillards, quatre mille Femmes, deux mille Filles, et quatre mille Enfans.*" And as there were then five such cantons, or Nations, this people, if the Baron or his authorities can be trusted, counted, considerably less than two centuries ago, from sixty to seventy thousand souls. Yet he gives as informants persons who had lived twenty years among them. Little reliance can be placed on the estimate: the ancient *Coureurs des Bois* were addicted to romancing; and the habit of perverting facts in reference to the more remote tribes they visited, by way of discouraging rivalry in their lucrative trade, must have clung to them when discussing those nearer home. Equally apochryphal, I cannot but suspect, must be the 20,000 warriors, whom King Oppecancanough somewhat earlier, is related to have led against the settlers in Virginia. Yet these, and other similar statements, which it would be easy to multiply, if they fail to furnish a numerical basis for comparison, convey a general idea of populousness, which, as compared with what is known of our

times, would justify anything that can be said as to the decline of the race. "There are abundant proofs," says Catlin, "in the history of the country, to which I need not at this time more particularly refer, to show that the very numerous and respectable part of the human family, which occupied the different parts of North America, at the time of its first settlement by Anglo-Americans, contained more than *fourteen millions*, who have been reduced since that time, and undoubtedly in consequence of that settlement, to *something less than two millions.*" (Catlin, ii, p. 238.) In the elaborate alphabetical enumeration of Indian tribes and nations, upwards of 400 in number, prefixed to Drake's well-known Book of the Indians: 10th Edit., 1848—we find the estimated numbers of a large proportion of them stated, but being of a great variety of dates, and the data probably of very variable authority, no general estimate can be based on it, without an analysis much more laborious than the result is likely to be accurate.

In the course of a couple of summers spent a few years ago in the Hudson's Bay territory, I took pains to arrive at an estimate of the actual numbers of Indians inhabiting that country, by enquiries among the resident traders, and by procuring, whenever possible, a specific statement of the number of hunters frequenting each Post, the number of young unmarried men, and an estimate of their families. The first two were, no doubt, ascertained very correctly, as far as the enquiry went; the last does not admit of much doubt. With respect to the districts which I visited, but from which I did not procure these data, it is not difficult to base a tolerable approximation on the information derived from observation and inquiry; and in respect to those which I did not visit, which, however, form but a small part of the territory, I am guided in the estimate by the facts that where there are no trading posts, there are no Indians, and that where there are trading posts, all the Indians of the district frequent them, habit having rendered the articles of European trade essential to their existence; consequently we may infer the number frequenting any given post pretty nearly when the scale of the establishment is known. There are, perhaps, a few exceptions to this remark in the district of Mackenzie's River, where our intercourse with many tribes is of recent origin; but it is true almost everywhere else. Whenever a conjectural addition was made, by well informed persons on the spot to the more precise numbers, it has been included in the following enumeration.

The British territory, in relation to its native population, may be divided into four regions. *First.*—The region west of the Rocky Mountains, and north of the parallel of 49°. *Second.*—The region east of the Rocky Mountains, but north of the parallel of 55°; the whole of which is inhabited by tribes of a common origin, and grouped by Ethnologists under the generic designation of "Tinné." *Third.*—The region from the parallel

of 55° to 49°, occupied partly by tribes of what is called the Eythinyuwuk or Algonquin stock, and partly by tribes of an intrusive race, kindred to the Iroquois or Five Nations. Lastly,—the British Colonies.

Beginning with the *Second* of these subdivisions, we have—North of Latitude 55° :

		Men.	Estim'd Total.	
(1.) Esquimaux—*Inu-it* not included.....		Unk'n.		
(2.) Loucheux—*Kutchin*.....				
On the Youcon and tributaries,—				
"	Richardson,	Artez-Kutchi.....	100	
"	p. 234.	Tchuè.....	100	
"	On the	Tathzey.....	230	
"	authority of	Kutchcha.....	90	
"	Mr. Murray	Zi-Unka.....	20	
"		Tanna.....	100	
"	1850.	Teytsè.....	100	
"		Vanta.....	80	
"		Neyetsè.....	40	
			860	
On Peel's River, 1844.....			413	5000
Fort Good Hope Mountain Indians.....			75	375
		Loucheux.....	15	75
Francis Lake, 1847–8.....			45	210
Pelly Banks "			73	368
				6028
(3.) Dogribs, Hares, Chipewyans, &c. *Tinnè*.....				
Fort Good Hope, Lowland Indians.....			28	150
"	Rapid Indians.....		11	55
Fort Norman Da-ha-Dinne, Dog-rib, Hare.....			140	690
Fort Simpson—Hares.....			107	
"	Do. Irregular.....		320	
"	Dog-rib.....		10	
"	Do. Irregular.....		50	
"	Nahanies.....		2	
"	Do. Irregular.....		4	2400
Fort Liard*—Hay River Indians, (Hares,).....			20	
"	Beaver or Chipewyan.....		30	
"	Slaves or Hares.....		10	
"	Thecanies.....		30	
"	Nahanies.....		14	600
Fort Resolution—Chipewyans.....			80	420
"	Yellow Knife.....		51	260
Big Island or Great Slave Lake Hares.....			20	100
Fort Chipewyan, Chipewyans.....			140	730
Vermillion Beaver Indians.....			62	250
Dunvegan Beaver Indians.....			87	
"	Seccanies.....		4	
Chipewyans.....			12	350
Unenumerated Chipewyan Stations.....			100	400
Churchill.....			110	660
Isle a la Crosse†.....				
Dog-rib and Martin's Lake Indians, said by Mr. Isbester not to be decreasing in numbers.....			150	600
				7575

* Franklin gave, in 1820, 685 hunters.

† Franklin rated them at 200 men and boys.

The foregoing enumeration, although it embraces a large extent of country, does not bring us into contact with the more numerous tribes, which are to be found only on the plains, where countless herds of Buffalo furnish ample means of subsistence. Without going into any nicety of classification, founded upon affinities of race, upon which subject Dr. Latham and Sir John Richardson (Arctic Expedition) have given much information, the tribes are referred to here by the designations they commonly bear among the traders. Mr. Harriet, then, a gentleman who had passed his life among them, estimated the six or seven tribes going by the general name of Blackfeet, as mustering 1,600 to 1,700 tents, at 8 per tent, 13,200.

Mr. Rowland, one of the oldest resident traders, gives them thus:—Sir John Franklin's estimate in 1820, is added—

		Franklin, 1820.
Blackfeet, proper, - - -	300	350
Pe-a-gans, - - - -	400	400
Blood Indians, - - -	250	300
Gros Ventres, or Fall Indians, -	400	500
Circees, - - - -	45	150
Cotones, } Mountain Tribes, {	100	
Small Robes, }	150	
	1645 at 8 p. t.	13,160
Mr. Shaw allowed to the Blackfeet, only - -		12,000

Considering that these are perfectly independent estimates, they agree remarkably, and we may take by their mean—

The Blackfeet tribes, - - - - 12,900

We have next the Assiniboines, a tribe of the Sioux, and said to be of the Iroquois stock: they are distinguished into those frequenting the woods, and those frequenting the plains, or Strongwood and Plain Assiniboines:

Mr. Harriet, in 1842, gave Strongwood -	80 tents.	
Mr. Rowland gave Plain Assiniboines, -	300	3,200
Mr. Shaw gave, both together - -		4,000
Giving for Assiniboines - - -		3,600

	Tents.	
For the Strongwood Crees about Edmonton, Mr. Rowland gave, - - -	100	4,000 }
Other Crees of the plains, - - - -	200	2,000 }
Mr. Shaw gave, - - - - - - -		4,000
(3.) Crees, - - - - - - - -		3,500
(4.) Ojibwas, or Chippewas of the Saskatchawan—Mr. Rowland, - - -	20 -	200

I. The aggregate, then, of the tribes inhabiting the Plains, in the British Territory, by competent authorities was, in 1843, not

more than 23,400. Catlin's estimate for the same tribes, is 35,000; but I found that all his numbers were regarded by better authorities (for Mr. Catlin did not visit the region here in question,) as too high.

II. We have next the various divisions of that widely diffused race, the *Eythinyuwuk* or Crees, which form the population of the wooded country east of the Great Plains, and south of the Churchill River, extending however in some instances *on* to the one, and *north* of the other. The Crees of the Plains we have already counted. There are a few Crees trading at Fort Chipewyan, at Isle a la Crosse, and at Lesser Slave Lake.

	Families.	Souls.
At Fort Chipewyan, - -	26	140
" Lesser Slave Lake, - -	83	341*
" Isle a la Crosse, and Green Lake,	100	600
" Cumberland House, - -		300†
" The Pas, or Basquan, - -		150†
" Norway House, - - -		300†
" Oxford House, - - -		100†
" York Factory, - - -		200†
" Beren's River, - - -		100†
" Red River dependencies, -		2000†
" Albany River, Martin's Falls,		500†
" Moose Factory and outposts,		500†
" Lake Tamiscaming, - -		200†
		5431

To this division belong the Chippewas or Ojibwas, Saulteurs, and Tetes de Boule of Lake Superior, Lake Huron, and their tributary waters. It was ascertained by the Honorable W. B. Robinson, Indian Commissioner in 1851, that the Indians on the north side of Lake Superior, from the Sault St. Mary to Pigeon River, and inland as far as the possessions of the Hudson's Bay Company, forming six bands, or subdivisions, were in all 1102 souls; and that the Indians on the north side of Lake Huron, from the Sault to French River, forming 17 bands, amounted to 1,422 souls, giving a total of 2,521. The bands were found to vary much in number, some comprising no more than 15, some as many as 241 souls. We have then—

	Souls.
Brought forward, - - - -	5,431
At Fort Alexander—Lake Winnepeg, -	200†
" Rat Portage—Lake of the Woods, -	120†
" Fort Francis—Rainy Lake, - -	400†
" Lake Superior, as above, - - -	1,102
" Lake Huron, as above, - - -	1,422
	8,675

* About one-third half-breeds. † Estimates only.

With respect to the Indians in Canada proper, it is stated in a very interesting report concerning them, (Journals of House of Assembly, 1844–5, Appendix 2,) that the earliest document received by the Government, which contains any detailed statement relative to the tribes, is one prepared by Major-General Darling, Military Secretary to Lord Dalhousie, in 1828. The total number of Indians who then came under the observation, and within the influence of the Government, in both Provinces, did not exceed 18,000. I am indebted to Col S. P. Jarvis, late Indian Superintendent, for the following authentic returns of their more recent numbers. In 1835, the number of resident Indians receiving presents, as they are improperly called, being rather annuities or rent charges upon the soil of Upper Canada, was stated as follows:

TABLE I.

	Men.	Women.	Boys und'r 15.	Girls und'r 15.	Total
Iroquois, or Six Nation Indians, including the Mohawks on the Bay of Quinté	598	727	543	545	2413
Hurons, or Wyandots	25	25	10	18	78
Chippewas	414	438	313	276	1441
Chippewas, called Mississaugus	208	246	157	125	736
Munsees, Delaware, or Leme-le-nape	44	51	36	26	158
Moravian Indians	78	79	55	44	256
	1397	1566	1114	1035	5082

The following table contains a statement in detail of the Indians in Upper Canada in 1838, compiled from a return made in answer to enquiries of the Secretary of State for the Colonies, (Lord Glenelg.) The corresponding numbers in 1844 and 1846, where they are given under the same denomination, are added from the returns of the Indian Department.

TABLE II.

Indians of Upper Canada. The details are from the very complete returns of 1838, *unless otherwise stated; and where corresponding totals are not given for the years* 1844 *and* 1846, *it arises from a more general form having been adopted in those years.*

	DENOMINATION.	1838.					1844.	1846.
		Men.	Women.	Under 15 Boys.	Under 15 Girls.	Total	Total.	Total.
	CHIPPEWAS.							
1	St. Clair Rapids	113	124	84	85	396	197	
2	Walpole Island or Chemail Ecarté	47	60	28	39	176	307	1129*
3	R. au Sables Lake Huron	11	6	4	10	27	117	
4	Up. St. Clair from Saginong	80	92	68	52	312	"	
	The same in 1844	218	234	159	130	"	741	684

* Pottawatomies and Ottawas are here included.

TABLE II.—(*Continued.*)

	DENOMINATION.	1838.					1844	1846.
		Men.	Women.	Under 15. Boys	Under 15. Girls.	Total	Total	Total.
5	Amherstburg	28	32	25	15	100	258	494*
6	Delaware, River Thames	121	120	79	57	377	378	438
7	Manitoulin Island, L. Huron	64	61	25	38	188	"	"
	The same in 1846	284	330	229	255	"	"	1098*
8	LaCloche and Mississaugeen	69	77	59	20	225	"	"
9	St. Joseph's Island, Lake Huron	23	26	17	24	90	"	"
10	Sault Ste. Marie	24	36	19	20	99	"	"
11	East Shore of Lake Huron	68	59	49	26	202	"	"
12	Owen's Sound, in 1846	42	54	20	20	"	"	139
13	Saugeen, Lake Huron	55	57	55	51	218	"	209
14	Yellowhead's Tribe, Rama	83	103	35	21	242	267	327
15	John Aisence's Tribe, do.	54	74	36	20	184	211	213
16	Lake Nipissing	18	16	10	15	59	"	"
	MISSISSAUGAS.							
17	River Credit, L. Ontario	68	77	52	43	240	254	245
18	Rice Lake	35	47	28	25	135	145	151
19	Mud Lake; Balsam Lake	45	52	35	27	159	175	194
20	Alnwick; on Rice Lake, from Grape Isl'd	63	71	45	35	214	233	218
21	Bedford, near Kingston, 1846	25	24	10	19	"	"	79
	IROQUOIS, OR SIX NATIONS, *on the Grand River.*							
22	Mohawks, Upper	81	105	87	90	363	374	406
23	" Lower	67	72	60	61	260	310	336
24	" from the Bay of Quinté	19	24	23	25	91	94	88
25	" on the Bay of Quinté	87	74	77	99	337	354	415
26	Oneidas, Joseph's	16	19	5	17	57	42	42
27	Onondagas, Clear Sky	51	68	36	25	178	219	225
28	" Bear or Barefoot	17	28	11	12	68	64	56
29	Senecas, Nekarontasas	8	13	11	10	42	55	70
30	" Kaghneghtasas	13	18	13	10	54	52	43
31	Cayugas, Upper	45	31	23	25	124	114	117
32	" Lower	105	97	48	69	319	287	311
33	Tuscaroras	38	55	30	39	162	192	202
34	Aughquagas, Joseph's	13	22	18	17	70	82	67
35	" Peter Green	23	22	20	22	87	75	68
36	Tutulies or Tutiloes	15	17	6	9	47	40	32
37	Minor denominations	12	28	22	25	87	96	102
	OTHER TRIBES.							
38	Ottawas, Manitoulin Island	26	22	14	18	80	"	"
39	Hurons, or Wyandots	34	21	13	17	85	88	"
40	Munsees, or Delawares	2	2	1	1	6	22	"
41	" on River Thames	64	74	55	49	242	242	157
42	" on Grand River	42	54	18	26	140	127	122
43	Potawatomies, at Saugeen	55	57	55	51	218	"	"
44	" St. Clair Rapids, 1844	141	170	101	94	"	507	"
45	" Upper St. Clair, 1846	27	33	21	14	"	"	95
46	Shawanoes, at Amherstburg	2	4	"	"	6	"	"
47	Moravian Indians, River Thames	41	42	29	31	143	143	187

The total numbers, as they appear at the foot of the above returns, exclusive of what are termed visiting Indians, most, or all of whom, come from regions beyond Lake Superior, and, if British Indians, are included elsewhere—are as follows:

* Pottawatomies and Ottawas are here included.

TABLE.

	1838	1844	1846	1847
Deserving Chiefs	52	31	29	
Warriors	38	38	51	
Women	62	41	41	
Ordinary Chiefs	134	162	178	
Warriors	1712	1274	2207	
Women	2091	2131	2599	
Boys, 10 to 15 years	422	492	573	
" 5 to 9 "	430	475	595	
" 1 to 4 "	553	433	690	
Girls, 10 to 14 "	310	421	455	
" 5 to 9 "	442	444	567	
" 1 to 4 "	497	481	773	
Totals	6643	6874	8756	8862

The Chiefs and Warriors in the first class, are those who served in the last war. The numbers in 1847 are taken from the Quebec *Gazette*. The apparent increase in 1846 is due to the permanent settlement of many Indians within the Province, previously residing beyond its limits, and was occasioned, as is well known, by the objection made on the part of the United States to our continuing to supply arms and ammunition to friendly natives belonging to their territory; the details of the table, however, when they are comparable, give satisfactory grounds for supposing that as regards the small portion of the Indian race inhabiting Canada, the worst is over. They appear to be slightly on the increase, and are at the same time acquiring to some extent the habits of civilized life.*

The following table of the number of Indians in Lower Canada, is taken from the Report presented to the Legislative Assembly, 1845, (Journal 1844–5, App. 2,) to which reference has been made before:

DENOMINATION.	Men.	Women.	Boys. 15 to 10.	Boys. 9 to 5.	Boys. under 5.	Girls. 15 to 10	Girls. 9 to 5.	Girls. under 5.	Total
Iroquois, Caughnawaga	266	306	61	67	72	53	66	64	955
" St. Regis, L. St. Francis	118	127	33	35	33	17	33	54	450
" Lake of Two Mountains	87	103	17	19	24	22	21	23	316
Algonquins, Lake of Two Mountains	95	116	23	20	19	29	26	5	332
" near Three Rivers	25	34	5	9	10	3	3	9	92
Nipissings, Lake of Two Mountains	75	85	23	15	12	17	29	7	263
Abenequais, St. Francis	100	111	14	27	32	14	26	26	353
" Becancœur	24	33	7	5	3	2	7	2	84
Hurons or Wyandots, la Jeune Lorette	64	55	8	6	11	16	13	16	189
Tetes de Boule, St. Maurice	31	22	1	10	8	6	6	3	86
Micmacs, Abenequois, and Amaleites, of uncertain residence	65	66	11	7			3	28	180
Totals	950	1058	203	220	224	179	233	234	2401

* The fact that the Mohawk Chief, John Brant, was once elected member of the House of Assembly, although he lost his seat for want of sufficient freehold property, deserves to be remembered.

It is to be regretted that the Lower Canadian returns do not distinguish the Iroquois according to the distinct nations of that once powerful confederacy. It will be observed, however, that the above numbers, combined with those of the Upper Canada return for 1846, make the number of chiefs and warriors still to amount to 1,220, and the total number to 4,301*. That their ancient loyalty to the British Crown is unabated, was shown by many incidents of the Canada rebellion, and by the language of their chiefs on the very interesting occasion of the meeting to restore General Brock's Monument in 1841. There is no native race entitled to claim, on so many grounds, the interest and respect of British inhabitants of Canada.

The following numbers of Indians in the several Counties, taken from the Census Returns of 1852, are added, to bring down the information on that subject to the latest date. It is evident, however, that the enumerators in Upper Canada did not always distinguish them from the rest of the population. There are, for example, none returned for the counties of Lambton and Essex, on the St. Clair,—thus the total is far below the truth,—but the list appears to be complete for lower Canada.

UPPER CANADA.—1852.		LOWER CANADA.—1852.	
Brant	1758	Beauharnois	754
Carleton	20	Bonaventure	451
Dundas	54	Champlain	31
Grey	374	Drummond	27
Grenville	48	Huntingdon	1259
Haldimand	310	Kamouraska	55
Kent	259	L'Islet	21
Northumberland	222	Megantic	14
Peel	12	Montmorency	26
Perth	8	Ottawa	5
	3065	Portneuf	12
		Quebec	218
		Rimouski	103
		Saguenay	663
		Terrebonne	11
		Two Mountains	408
			4058

The number of Indians on the lower St. Lawrence, frequenting the King's posts of the Hudson's Bay Company, is not known, but must be insignificant. I believe this to be also the case of the Indians in Nova Scotia and New Brunswick, but have no access, at present, to authentic returns.

We have still to consider the population west of the Rocky Mountains, in New Caledonia.

* The Mohawks of the Bay of Quinté are included, but the Delaware of the Thames are excluded, as never belonging to the Six Nations, although at present associated with them in all the returns of the Indian Department.

In 1820, Harmon, who had lived long among them, stated that the number, of all ages, did not exceed 5,000; they have diminished since with fearful rapidity, probably faster in that quarter than in any other. Mr. McGillivray, in Ross Cox's Travels, of somewhat earlier date, makes the tribes inhabiting the country about Frazer's River, the most populous part of the country, to number no more than 1.012 souls, including the Chilcotins, Naskotins, Tolkotins, and Atnahs—four tribes. Captain Wilkes, in 1840, upon a very careful survey, and doubtless upon much more complete and authentic data, than either of the others, makes the total population of Oregon and New Caledonia together, amount to 19,354 souls, about two-thirds of whom M. Duflot de Mofras estimates for Oregon alone. So that on the whole, I consider that 2,000 for the interior of New Caledonia, (Oregon no longer being British territory,) is an ample allowance.

We have also to include the large Islands of Quadra or Vancouver's, and Queen Charlotte, together with the seaboard of that region. The population of the former has been estimated at from 10,000 to 20,000, and that of the latter at from 7,000 to 10,000.

By the kindness of Mr. Kane, whose labors as an artist in the least known parts of this continent, have yet to be fully appreciated, I am enabled to present an abstract of a very full census of Indian tribes inhabiting the northwest coast, which he procured in 1847. If it can claim anything like the general accuracy and fidelity of his pictures of Indian life, we need not hesitate to adopt it.

TABLE III.

COMMON DESIGNATION AMONG THE TRADERS.	Tribes	ADULTS.		CHILDREN.		Slaves.	Houses
		Men.	Wom.	Boys.	Girls.		
Nass Indians*	4	543	438	314	308	12	82
Chimseyans	10	737	778	465	466	68	257
Skeena Indians	2	131	72	64	59		30
Sabassas	5	474	407	243	194	111	
Milbank Sound Indians†	9	1007	961	394	462	47	122
Chilcat, &c‡	7	1249	961	469	418	479	
Stekene Indians§	8	562	410	240	190	144	59
Port Stuart‖	3	180	185	141	157	15	27
Kygarney¶	6	431	454	414	436		111
Queen Charlotte Sound**	6	1029	1035	962	1003		257
About Queen Charlotte Sound††	25	7370	8890	9949	11491	1472	735
Cape Scot and vicinity	4	730	875	1290	1290	210	74
Total		14443	15466	14972	16474	2558	1724

* Trade at Fort Simpson, Vancouver's Island, and generally reside in its vicinity.
† Trade at Fort McLaughlin.
‡ Trade at Sitka, Sitkene and Tacca.
§ Trade generally at Stikene, but frequently visit Fort Simpson.
‖ Trade generally at Fort Simpson.
¶ Frequent Ft. Simpson Stikene, Zacca and Sitka.
** Frequent Fort Simpson.
†† Frequent Fort McLaughlin.

We may now proceed to reckon up the result, not forgetting that the region under discussion is equal in extent to one-twentieth part of the habitable surface of the globe, and has been generally looked upon as the asylum and stronghold of the race of North American Indians. Excluding the Esquimaux, whose numbers, notwithstanding the great extent of sea-line they occupy, cannot be large—probably not more that two or three thousand—we have the following enumeration:

Chipewyan tribes, namely, Chipewyans proper, Dog-ribs, Hare or Slave Indians, Yellow Knives, Beaver Indians, Da-ha-dinnies, and Carriers, - - - -	7,575
Northern Indians of the *Kutchin* stock, - - -	6,028
Ethiny-u-wuk Indians of the Plains, - - - -	23,400
Chipeways and Crees, exclusive of the above, - -	8,675
Indians of the Seaboard and Islands of the Pacific, -	63,840
Indians of New Caledonia—interior, - - - -	2,000
Indians of Canada, - - - - - -	13,000
Grand Total, - - - - - -	124,518

Or to drop the appearance of precision conveyed by the broken numbers, 125,000, being barely double the number at which De la Hontan estimated the Six Nations of the Iroquois alone, in 1690.

I am conscious that this number, for the gross population of so large a portion of the whole Continent, may appear almost incredibly small. In going over carefully and reconsidering the details, I do not believe them to be, upon the whole, under estimated. No important region of the British territory appears to be omitted. It is presented, therefore, as an approximation, which may at least serve to direct further attention to the subject. It is, of course, to be taken as representing only a portion of the race. I have no means of estimating the native population of Russian America, and we have not considered the native population of the United States, Texas, Mexico, and Oregon. The first of these was estimated in 1835 at 330,000, which, however, I take to be too high. Mr. Cuthbertson, a naturalist, travelling for the Smithsonian Institution at Washington, gives the following for the probable number of Indians on the Upper Missouri and its tributaries, in 1850. (Fifth Annual Report of Board of Regents, 1851.)

Sioux, - - - - - -	30,000
Cheyene, - - - - - -	3,000
Ariccaree, - - - - -	15,000
Mandan, - - - - - -	150
Gros Ventres, - - - - -	700
Assiniboine, - - - - -	4,800
Crow, - - - - - -	4,800
Blackfoot, - - - - -	9,800
Total, - - - - -	54,550

Among whom appear to be included some of those frequenting the British trading posts, and previously reckoned. It is scarcely possible that the Indians of the Lower Missouri, Texas, and Mexico, can make up even an approximation to the 330,000 of the Baptist Committee. (Religion in America, p. 56.) Putting the whole together, it would scarcely seem that the present aggregate can be placed so high as 250,000, instead of the two millions of Catlin.

To this remnant, then, has been reduced a race supposed to have numbered from ten to twenty millions, not more than three centuries ago. "War, death, or sickness hath laid seige to it," and is still laying seige at a rate in no degree less rapid than at any former period. Not to mention the cruel destruction effected by the American fur traders and trappers in the South; by utter lawlessness and wanton disregard of humanity; by Florida wars and wholesale deportations; we find that even in regions where the more obviously depopulating agencies have been held in great restraint, the process goes on. The Indians themselves are fully aware of it, and fully conscious also that the whites cannot always be directly charged with it. Sir John Richardson has given us a curious mythological tradition which serves to account for it to the Kutchin, (p. 239.) A friend of mine, who conferred on the subject with a sage old native of New Caledonia, found that his only theory was that the white men's tobacco poisoned them. The white's fire water in this case, and throughout the Hudson's Bay territory, is happily guiltless, for none enters the country.* If we charge it, in the case of the Carrier, to the unbounded licentiousness which prevails among them, we have to account for the same causes not having had the same effect at earlier periods; for, with the sole exception of the Indians of Virginia, boundless licentiousness appears to have been the rule among the natives on our first acquaintance with them. The travels of Lewis and Clark beyond the Mississippi, only half a century ago, fully corroborate the accounts of all travellers of the seventeenth century in Canada and the more Eastern regions, in respect to this characteristic.

Doubtless, some causes can be assigned, which tend to reduce the physical stamina of the race—such as the substitution of inferior European clothing for their native robes of fur; the use of stimulants, tobacco almost universally, alcohol partially; the gradual loss of native arts and appliances, without the acquirement of anything better; the introduction of new forms of disease; a marked deterioration in their dwellings, from the skins of

* I cannot avoid referring Temperance advocates to the amusing Essay, "Sur l'Yvrognerie des Sauvages," in the Histoire de l'eau-de-vie en Canada, 1705; reprinted by the Literary and Historical Society of Quebec. It is well to know that, *il n'y a qu'une mesure d'yvresse qu'ils appellent* Ganoutiouaratonseri, c'est **a dire, Y*vrognerie pleine!***

which they were formerly made acquiring a market value, but being exchanged for nothing so essential to their health. There are also moral causes tending to depress the race—such as the consciousness of decline; the pressure of new necessities; the hopeless sense of inferiority to the whites in many respects, which, with all their reputed pride, is a general feeling among the Indians. Lastly, we must add the influence of practices which have a frightful prevalence in certain districts. I mean the administration of potions destined sometimes to produce abortion, sometimes to cause absolute sterility, in females. Dr. Hodder, in an Essay on the Poisonous Plants of Canada, read since the date of this paper, has alluded to the former as one of the secrets of the Indians in Canada, which he has not succeeded in discovering, but to which he attributes, in a very great degree, their decrease in number. Many instances of the latter were related to me in the interior—the Crees, more particularly, have a bad eminence as medicine men, which shews a general disposition among them to the unnatural arts. In fact, they are stated to be among the commonest resources of jealousy and revenge. However, some of these causes have not been found to check the reproductiveness of other races; and it may be doubted whether any or all of them are adequate to explain the broad fact, the final solution of which can probably be found only in the supposition of a design of Providence to make way for one race by removing the other.

ART. XXII.—*On the Constitution and Equivalent Volume of some Mineral species;* by T. S. HUNT, of the Geological Commission of Canada.

IN a recent paper, we have endeavored to lay down some principles as the basis of a sound theory of chemistry.* Having explained the nature of chemical changes, and the laws of combination, we showed that the volumes of the uniting species are always merged in that of the new one, so that the atomic theory, as applied by Dalton, which makes combination consist in juxta-

* This Journal for March, 1853, p. 226, and London Phil. Mag. for June, Supplement, p. 526. The readers of that article in this Journal will please make the following corrections: p. 226, 10th line from the bottom, for *the capacity of such changes*, read *the capacity of such complete change*, etc.; and in the last line of the next page, for *it transcends the limits of human knowledge*, read *it transcends all sensible knowledge.*

The term *metagenesis*, found on page 227, has been used by Owen to designate that multiform or serial generation observed in many of the lower orders of life; this, however, is not strictly a metagenesis, and the term if not rightly understood may lead to grave errors. As applied to chemical transformations, it appears, however, to be unobjectionable.

position, is untenable. It was further asserted, that the simple relations of volumes which Gay Lussac pointed out in the chemical changes of gases, apply to all liquid and solid species, thus leading the way to a correct understanding of the equivalent volumes of the latter. While chemists have not hesitated to assign high equivalents to bodies of the carbon series, they have been inclined to make the equivalent weights of denser mineral species correspond, to formulas representing the simplest possible ratios. We have endeavored from a consideration of the theory of equivalent volumes, to point out the errors to which this method has led, and to show that we must assign to most mineral species much higher equivalent weights than have hitherto been admitted.

It was further asserted, that a relation similar to that observed in the formulas of allied hydro-carbonaceous bodies, and designated as chemical homology, exists in the formulas of mineral species. We have said that these formulas, deduced from the results of analysis, are not to be looked upon as expressing any pre-existing relations in the constitution of the species, which is not to be regarded as a compound, but as an individual, in which the so-called chemical elements have no actual existence. The arrangements of these in our formulas, only serve to make apparent the numerical relations which have been found to govern the transformations of the higher species.

The formulas of homologous bodies may be represented as series in arithmetical progression. The first term may be the same as the common difference, and the series is then

$$b,\ 2b,\ 3b \ldots nb,$$

as in the hydrocarbons C_2H_2, C_4H_4, C_6H_6, etc. If the first term is unlike the common difference, the series is

$$a,\ a+b,\ a+2b, \ldots a+nb,$$

of which the ammonias, NH_3, $NH_3+C_2H_2$, $NH_3+2C_2H_2$, etc., are examples. Both of these cases are illustrated in the chemical history of mineral species.

In the paper already referred to, it has been shown, from the relations of carbon, sulphur and oxygen on the one hand, and of hydrogen with the metals on the other, that M_2S_2, M_2O_2, and H_2O (M representing any metal), may be compared with H_2C_2. This view will be applied in extending the application of the principle of homology. The sesqui-oxyds like ferric oxyd, chromic oxyd, and alumina, will be regarded as oxyds of *ferricum*, *chromicum*, and *aluminicum*, having two-thirds the equivalents ordinarily assigned to these metals, and represented by fe, cr and al, so that Fe_2O_3, becomes 3feO, capable of replacing 3MgO, or 3FeO. In the same way arsenic and antimony in one-third their usual equivalents may be represented by as, sb, and AsO_3 becomes

3asO. Silica, SiO_3 may also be written as 3siO, for the multiple equivalent weight assigned to it, is deduced from certain silicious species whose formulas are as simply written with the lesser equivalent; by this means all these oxyds may be reduced to the type M_2O_2.

We have further asserted, that for species crystallizing in the same form, the density varies directly as the equivalent weight, so that the quantities obtained in dividing the one by the other, and known as the atomic or equivalent volume, will be equal. Such a relation is already recognized between species of the same genus, and we now propose, having fixed an equivalent weight for one species, to calculate from their densities, those of the species isomorphous with it, and to show from the formulas corresponding to these equivalent weights, that the different genera thus related are homologous, or exhibit other intimate relations.

In this investigation of mineral species, several circumstances combine to render the attainment of accurate results exceedingly difficult. Native crystals are often neither compact nor homogeneous, and the presence of fissures filled with air, or other foreign species, makes the determination of density uncertain. Impurities also render the results of analysis doubtful, and if we employ the formulas generally assigned, it will be found that an attempt to deduce the most simple relations from the results of analysis, or to make these conform to some arbitrary assumption, has led chemists to adopt numbers which are often considerably at variance with experiment, and to disregard one or two hundredths of some element, which is perhaps essential to the constitution of the species. This is probably in an especial manner true of the small portions of water and fluorine in certain silicates, which are determined together as the loss by ignition, and disregarded in the construction of the formulas. The uncertainty with regard to the equivalent weight of silica is also a source of embarrassment in the examination and comparison of formulas. According to Pelouze, SiO_3 is 45·34 (O=8) while the corrected determinations of Berzelius make it 46·22. The latter number, adopted by Rose in the tables accompanying the last edition of his Analytical Chemistry, will be employed for the calculation of equivalent weights in the present paper.

In many artificial crystals those difficulties are less felt, and the equivalent volumes are closely accordant. We cite for illustration the following results from an elaborate memoir on atomic volumes, by Playfair and Joule. (Qu. Jour. Chem. Soc., p. 121.) These phosphates and arseniates crystallize in the monoclinic system; the densities here given are the means of several determinations.

Species.	Formula.	Equiv. wt.	Density.	Volume.
Phosphate soda,	$PO_8Na_2H, 24HO$	359·1	1·525	235·5
Sub-phos. soda,	$PO_8Na_3, 24HO$	381·6	1·622	235·2
Arseniate soda,	$AsO_8Na_2H, 24HO$	402·9	1·736	233·0
Sub-arsen. soda,	$AsO_8Na_3, 24HO$	425·2	1·804	235·6

The four species of alum examined by these experimenters exhibit a similar relation. They are monometric in crystallization, and, like the last, are represented with 24HO, common alum being $S_4al_3KO_{16}.24HO$; the al may be replaced by fe or cr, and the K by NH_4, as in the following species. The equivalents given by Playfair and Joule have been corrected from later determinations of chromium and aluminum.

Formula.	Equiv. wt.	Density	Volume.
$S_4al_3KO_{16}, 24HO$	474·6	1·731	274·1
$S_4al_3(NH_4)O_{16}, 24HO$	453·4	1·625	279·0
$S_4cr_3KO_{16}, 24HO$	500·6	1·843	271·6
$S_4fe_3(NH_4)O_{16}, 24HO$	482·0	1·715	280·5

The densities here adopted are the means of those of several experimenters. Playfair and Joule, from different specimens of the same species, obtained results, some of which we cite to show the amount of variation in crystals of a pure salt. Thus, for potash alum the numbers 1·726 and 1·751 were obtained, giving respectively 275 and 271 for the volume; and for chrome alum, the densities 1·826 and 1·856, corresponding to 274·15 and 268·6. For reasons already given, the presumption in these salts is in favor of the greater density, adopting which, we have for the mean of the four species 274·6, and for the first three, 272·8, as the equivalent volume.

The monometric species leucite is represented by the formula $\dot{K}_3\ddot{S}i_2 + 3\ddot{A}l\ddot{S}i_2$, which expanded becomes Si_3O_{24}, $(al_6K_3)O_{12}$ with an equivalent of 665·22 and a density of 2·49, giving 267 for the volume. The triclinic species andesine, belonging to the same type, has an equivalent of 622·2 and a density of 2·7, giving 230·4 for its volume. This difference of volume in these and other dimorphous species has already been pointed out by Dana.

If we turn from the alums and leucite, to the chlorids of potassium and sodium, which likewise crystallize in the regular system, we find at first sight no apparent relation with the former, or between each other. The one NaCl, with an equivalent weight of 59·4, has a density of 2·257, which gives 26·3 for its volume, while the chlorid of potassium KCl, with an equivalent of 74·5, has a density of only 1·978, (P. and Joule,) giving a volume of 37·67. If we suppose crystallized sea salt to be 10NaCl, we shall have 263· for its volume, and the potassium salt may be 7KCl, with a volume of 265·7. We are thus led to the conclusion arrived at by Favre and Silbermann, from their experiments

upon the heat evolved in fusion and solution, that the equivalent weights of crystallized salts are multiples of those deduced from the analysis of these same salts in solution.

In order to establish a starting point, it will be necessary to determine the volumes of some species, whose combining proportions are known to be very high in proportion to their densities. Ferrocyanid of potassium, $C_{12}N_6Fe_2K_4$, 6HO, has an equivalent weight of 422·8 and a density of 1·832, giving 230 for its volume; milk-sugar, $C_{24}H_{24}O_{24}$, has an equivalent of 360, with a density of 1·534, and a volume of 234; and cane-sugar, $C_{24}H_{22}O_{22}$ gives 342, with a density of 1·593, and a volume of 215. These species approach to andesine in equivalent volume. The formula of the combining proportion of piperine, deduced from its platinic chlorid, is established by the researches of Wertheim, as corrected by Gerhardt, to be $C_{72}H_{36}N_2O_{10}$, to which in the monoclinic crystallized alkaloid, H_2O_2 is to be added, giving an equivalent weight of 582. I obtained for its density in three experiments with a carefully purified specimen, 1·238, 1·244 and 1·250, giving a mean of 1·244, which corresponds to an equivalent volume of 467·8, or double that calculated for andesine, the soda salts, and other prismatic species above. We may therefore double the equivalents of these species, as well as those of leucite and the alums. Their formulas and equivalent volumes will then be as follows:

Alum,	$S_8O_{24}(al_6K_2H_{48})O_{56}$	548·0
Sea-salt,	$Na_{20}Cl_{20}$	526·0
Chlorid of potassium,	$K_{14}Cl_{14}$	531·4
Leucite,	$Si_{16}O_{48}(al_{18}K_6)O_{24}$	534·0
Andesine,	$Si_{16}O_{48}(al_{18}Na_3Ca_2K)O_{24}$	460·8
Piperine,	$C_{72}H_{36}N_2O_{10}, H_2O_2$	467·8

The relation which we have seen between the alkaline chlorids is one of homology, similar to that between the hydrocarbons $n(C_2H_2)$, and an examination of some oxyds crystallizing in the regular system, will furnish further examples of the same relation. Magnetite $FeO, Fe_2O_3 = (Fe\,fe_3)O_4$, with a density of 5·094, gives a volume of 22·7; if we multiply its equivalent by twenty-four, it becomes $(Fe_{24}fe_{72})O_{96}$ with a volume of 544·8; several other species as franklinite, chromoferrite, martite, have a similar volume; but red copper ore ϵuO, with an equivalent weight of 71·4, and a density of 6, gives a volume of 11·9, so that its formula will be $\epsilon_{36}O_{36}$, with a volume of 547·4, while melaconite CuO, with an equivalent weight of 39·7, and a mean density 5·25, has a volume of 7·54, which gives for $Cu_{72}O_{72}$, a volume of 543·0. Arsenious acid AsO_3 with an equivalent weight of 99· and a density of 3·7, has a volume of 27·, giving for $As_{20}O_{60} = as_{60}O_{60}$, a volume of 540.

From these examples it appears that identity of volume in allied and isomorphous species, requires higher equivalents and more complex formulas than are generally assigned, and that these new formulas are homologous. We deduce the equivalent weight of a monometric species like that of a gaseous hydrocarbon from its density.

The rhombohedral species of the calcite group are commonly cited as example of identity in equivalent volume, but even this group presents exceptions such as we have seen in the monometric oxyds and chlorids. Calcite is remarkable for the variations in the density of different specimens. According to Beudant* the purest varieties give from 2·5239 to 2·7234. With the formula $C\,Ca\,O_3 = 50$ and a density of 2·72, the volume is 18·4, and with 2·52 it equals 19·84. The magnesite from Arendal which contains only ·73 p. c. of oxyd of iron, gave to Scheerer a density of 3·068; if we take 3 for the pure carbonate, the equivalent volume will be 14, and calamine with a density of 4·45, gives the same number. Dolomite of density 2·9 gives a volume of 15·9, and diallogite with a density of 3·592, equals 15·6, while spathic iron with a specific gravity of 3·8 has a volume of 15·2. We give here the volume and the angles of the rhombohedron for these species.

Species.	Volume.	Angle R : R.
Calamine,	14·0	107° 40′
Magnesite,	14·0	107° 22′
Spathic iron,	15·2	107°–107° 5′
Diallogite,	15·6	106° 51′. 107° 20′, Levy and Breithaupt.
Dolomite,	15·9	106° 10′–106° 20′
Calcite,	18·4–19·8	105° 5′–105° 25′

Kopp has endeavored to connect these variations in volume with the different dimensions of the rhombohedron in the several species, but it seems probable on comparing the corrected numbers, that this apparent relation is accidental. Besides the variations in density presented by calcite, it will be seen that the difference between the angles of calamine and magnesite, whose volumes are identical, is the same as that between the latter and spathic iron; the angle assigned by Levy and Breithaupt to diallogite, differs only 2′ from that of magnesite, while the volume of the species is near that of dolomite. The importance to be attached to the small variations in angular measurement, is lessened by the differences in the angles of the same species, amounting to from 5′ to 20′, and by the variations observed by Nicklès in many artificial crystals, often amounting to 1° and 1° 30′, and seemingly dependent upon portions of foreign matters, sometimes too small to be detected by chemical analysis.†

*Annales des Mines, (2.) v. p. 275, cited in Dana's Mineralogy, 3d Ed. p. 206.
† Comptes Rend. des Trav., 1850, p. 193.

To the above series of isomorphous species, Rose has added soda-nitre, which has R : R 106° 33′, light red silver ore, proustite, having R : R 107° 36′, and dark red silver ore, pyrargyrite R : R 108° 18′. Soda-nitre $NNaO_6$ with a density of 2·26 (P. and Joule) gives 37·6 for its equivalent volume; proustite $(AgS)_3 + AsS_3$, with a density of 5·5, gives 91, while pyrargyrite, in which antimony replaces the arsenic of the last formula, has a density of 5·8 and a volume of 94.

This series then presents wide variations in volume, and it is only by adopting more elevated equivalent weights, that a simple relation becomes apparent. We shall endeavor to fix these equivalents as before from the densities of the species. The formulas of the silver ores are to be multiplied by six, for a reason which will be assigned farther on, and we have then for the formula of proustite, $Ag_{18}As_6S_{36}$ with a volume of 546, while the antimonial species, and soda-nitre $N_{15}Na_{15}O_{90}$ have each a volume of 564. Calamine then becomes $C_{10}Zn_{40}O_{120}$, with a volume of 560, magnesite being the same. Dolomite $C_{36}(Ca_{18}Mg_{18})O_{108}$ gives a volume of 554, and spathic iron $C_{36}Fe_{36}O_{108}=547$, while the diallogite of Kapnik is represented by $C_{36}(Mn_{32}Ca_{2\cdot5}Mg_{1\cdot5})O_{108}$, and with a density of 3·592, has a volume of 563. Calcite of the density 2·72, and the formula $C_{30}Ca_{30}O_{90}$, gives 555·5 for its volume, while that with a density of 2·52, may be represented by $C_{28}Ca_{28}O_{84}$, with a volume of 552. With these formulas it is apparent that there may be a great number of intermediate species from partial substitutions.

According to the above formulas, we have in the rhombohedral carbonates, several genera belonging to a homologous series of the first kind. These genera have the same volume, and are represented by the general formula $n\,C_2M_2O_6$: that of the nitrates is NMO_6, and light red silver ore $AsAg_3S_6 = as_3Ag_3S_6$, so that the general formulas of these three groups offer a very interesting resemblance, which was first pointed out by Gerhardt;* they are

$$n\,N\,M\,O_6$$
$$n\,C_2M_2O_6$$
$$n\,as_3M_3S_6$$

The arragonite group is not less worthy of notice, and Rose has shown that potash-nitre and bournonite are isomorphous with these prismatic carbonates. The density of this series is greater than that of the last; Rammelsberg's formula for Bournonite is $(3CuS, SbS_3)+2(3PbS, SbS_3)$ which equals $(Cu_3Pb_6)Sb_3S_{13}$; this with a density of 5·85, according to recent determinations by the same chemist, gives a volume of 254, which we double to compare with the volume of piperine, and with that adopted for leucite and the alums. Bournonite has the same chemical

* Comptes Rend. des Trav. de Chimie, 1849, p. 322.

type as the red silver ores, and it is to compare them with it, that we have multiplied the received formulas of these species by six.

Taking then 508 for the volume of bournonite, the formula of arragonite may be written $C_{30}Ca_{30}O_{90}$ with a volume of 510·; witherite is $C_{22}Ba_{22}O_{66}=503{\cdot}8$, while strontianite is $C_{25}Sr_{25}O_{75}=505$, and cerusite has the same type and volume. Bromlite is represented by $C_{25}(Ca_{12{\cdot}5}Ba_{12{\cdot}5})O_{75}$ with a volume of 500, and barytocalcite, the monoclinic form of the species, gives for the same formula 507·5. Nitrate of potash with the formula $N_{10.5}K_{10.5}O_{63}$ has a volume of 506.

From the fact that it is here found necessary to assign a fractional value to n in the formulas of the nitrates and carbonates, we are led to infer that the equivalent weights here assumed, are as yet too low, and must at least be doubled. We however retain for the present, the fractional equivalents, and subjoin the formulas and calculated volumes of the two series.

Rhombohedral Species.

		Density.	Volume.
Proustite, }	$As_6Ag_{18}S_{36}$	5·50	546
Pyrargyrite, }	$Sb_6Ag_{18}S_{36}$	5·80	564
Soda-nitre,	$N_{15}Na_{15}O_{90}$	2·26	564
Calamine, }	$C_{40}Zn_{40}O_{120}$	4·45	560
Magnesite, }	$C_{40}Mg_{40}O_{120}$	3·00	560
Dolomite, }	$C_{36}(Mg_{18}Ca_{18})O_{108}$	2·90	554
Spathic iron, }	$C_{36}Fe_{36}O_{108}$	3·80	547
Diallogite, }	$C_{36}(Mn_{32}Ca_{2\cdot5}Mg_{1\cdot5})O_{108}$	3·59	563
Calcite,	$C_{30}Ca_{30}O_{90}$	2·72	555·5
Do.,	$C_{28}Ca_{28}O_{84}$	2·52	552

Trimetric Species.

		Density.	Volume.
Bournonite,	$Sb_6(Cu_6Pb_{12})S_{36}$	5·85	508
Potash-nitre,	$N_{10\cdot5}K_{10\cdot5}O_{63}$	2·10	506
Arragonite,	$C_{30}Ca_{30}O_{90}$	2·93	510
Strontianite, }	$C_{25}Sr_{25}O_{75}$	3·65	505
Cerusite, }	$C_{25}Pb_{25}O_{75}$	6·60	505
Bromlite, }	$C_{25}(Ba_{12{\cdot}5}Ca_{12\cdot5})O_{75}$	3·71	500
Witherite,	$C_{22}Ba_{22}O_{66}$	4·30	504

An interesting example of homology is afforded in the tourmalines whose composition has been well shown in the late admirable series of analyses by Rammelsberg. The ordinary rhombohedron of this species gives R : R 133° 26′ (132°—134°, Breithaupt,) but the rhombohedron 2R has the angle 103° 21′, or nearly that of calcite. Rammelsberg has analyzed thirty varieties of this species, all of which yield boracic acid in quantities varying from six to nine per cent., and from 1·3 to 2·7 per

cent. of fluorine. This last is given off by ignition as fluorid of silicon or boron, and the mineral then becomes soluble in hydrochloric acid. Rammelsberg admits that silicic and boracic acids replace each other, and finds that the ratios between the protoxyds, sesquioxyds, and the two acids, vary exceedingly in the different varieties. Without regarding the fluorine, he divides the species into the five following groups.*

1st. *Magnesia tourmalines.* $\dot{R}_3\ddot{S}i_2+3\ddot{R}\ddot{S}i$; the mean equivalent weight deduced from six varieties is according to Rammelsberg 441·15 (O=8), and the mean density 3·05, giving an equivalent volume of 144·6.

2nd. *Magnesia-iron tourmalines.* $\dot{R}_3\ddot{S}i_2+4\ddot{R}\ddot{S}i$, with a mean equivalent weight deduced from eight varieties of 518·81, and a mean density of 3·10, giving 167·3 for the equivalent volume.

3rd. *Iron tourmalines.* $\dot{R}_3\ddot{S}i_2+6\ddot{R}\ddot{S}i$; the mean equivalent of six varieties is 777·20, and the mean density 3·2, giving 241 for the equivalent volume.

4th. *Iron-manganese tourmalines.* $\dot{R}\ddot{S}i+3\ddot{R}\ddot{S}i$; the mean equivalent weight of six varieties was 360·36, and the mean density 3·08, giving a volume of 117·0.

5th. *Manganese tourmalines.* $\dot{R}\ddot{S}i+4\ddot{R}\ddot{S}i$; the mean equivalent weight of four varieties was 449·3 and the mean density 3·04, giving 148 for the equivalent volume.

A red tourmaline from Rozena of density 2·998, yields according to Rammelsberg the formula $\dot{R}\ddot{S}i_2+5\ddot{R}\ddot{S}i$.

If we represent R_2O_3 by 3rO, the formulas of these five groups become as follows:

1st. $Si_5O_{15}(R_3r_9)O_{12}$.
2nd. $Si_6O_{18}(R_3r_{12})O_{15}$.
3rd. $Si_8O_{24}(R_3r_{18})O_{45}$.
4th. $Si_4O_{12}(R\ r_9)O_{22}$.
5th. $Si_5O_{15}(R\ r_{12})O_{13}$.

Multiplying by four the formulas and equivalents of the 1st and 5th, so as to make Si_{20}, and then by a simple proportion raising the others to the same scale, we obtain the following formulas and equivalents.

		Mean equiv.	Mean D.	Eq. vol.
1st.	$Si_{20}O_{60}(R_{12}r_{36})O_{48}$	1764·6	3·05	578
2nd.	$Si_{20}O_{60}(R_{10}r_{40})O_{50}$	1729·2	3·10	558
3rd.	$Si_{20}O_{60}(R_{7\frac{1}{2}}r_{45})O_{52\frac{1}{2}}$	1928·6	3·20	602
4th.	$Si_{20}O_{60}(R_5r_{45})O_{50}$	1800·0	3·08	584
5th.	$Si_{20}O_{60}(R_4r_{48})O_{52}$	1799·6	3·04	592

It will be seen that the 2nd and 4th have similar formulas, and differ by R_2O_2 from the first, while the 3rd, rejecting as insig-

* Pogg. Annal., 1850, Nos. 8 and 9, and this Journal, vol. xi. p. 257.

nificant the fraction, is like the 5th, and differs from the 1st by R_4O_4. The tourmaline of Rozena is $Si_{7}O_{21}(R\ r_{15})O_{16} = Si_{20}O_{60}(R_3r_{43})O_{46}$, so that we have the four following homologous genera, the last two having each two species.

$Si_{20}O_{60}$, $M_{46}O_{46} = (si_{60}, r_{43}, R_3)O_{106}$.
$Si_{20}O_{60}$, $M_{48}O_{48} = (si_{60}, r_{36}, R_{12})O_{108}$.
$Si_{20}O_{60}$, $M_{50}O_{50} = (si_{60}, r_{40}, R_{10})O_{110}$, and $(si_{60}, r_{45}R_5)O_{110}$.
$Si_{20}O_{60}$, $M_{52}O_{52} = (si_{60}, r_{45}, R_7)O_{112}$, and $(si_{60}, r_{43}R_4)O_{113}$.

The variations in the calculated volumes of the tourmalines are greater than we have found in some other isomorphous species. Instead of taking the equivalent weight and greatest density of each variety, Rammelsberg has only calculated the volume of each group, from a mean of the equivalents and densities, a method which cannot be expected to give accurate results.

The following monoclinic crystals have been indicated by Mr. Dana, as isomorphous; borax, glauber-salt, spodumene, pyroxene, acmite and hornblende.*

The sulphates being bibasic, glauber salt is $S_2Na_2O_3, 20HO = 322{\cdot}4$, which, with a density of 1·469, gives a volume of 219, or doubling the formula 438. Borax is $2BO_3, NaO, 10HO$, which multiplied by four gives with a density of 1·73, an equivalent volume of 441·6.

Spodumene is represented by $(\dot{N}a\frac{1}{3}\dot{L}i\frac{2}{3})_3\ddot{S}i_2 + 4\ddot{A}l\ddot{S}i_2$, which multiplied by two and expanded, becomes $si_{60}O_{60}(al_{24}Li_4Na_2)O_{30}$, with an equivalent weight of 1455·5 and a density of 3·18 giving a volume of 457. The formula of white pyroxene, diopside, is $si_{52}O_{52}(Ca_{13}Mg_{13})O_{26}$ which with a density of 3·24, gives also the volume 457. Hedenbergite belongs to the same type, and is $si_{52}O_{52}(Ca_{13}Fe_{12}Mg)O_{26}$ with a density of 3·5 and a volume of 462. The aluminous augite, hudsonite, is represented by $(si_{38}al_{10})O_{48}$, $(Fe_{16}Ca_7Mn)O_{24}$, and with a density of 3·46 gives a volume of 448. Wollastonite, a lime pyroxene, approximatively isomorphous with the above species, is $si_{44}O_{44}Ca_{22}O_{22}$, and with a density of 2·9 has a volume of 446·16.

In the different varieties of augite or pyroxene, the oxygen of the silica, or of the silica and alumina combined, is to the oxygen of the protoxyd bases as 2 : 1, while in the hornblendes the ratio is as 9 : 4. There are however many examples of minerals with the cleavage of pyroxene and the formula of hornblende, while there are hornblendes whose analyses give the augite ratio of 2 : 1. Carinthite with the form of a hornblende, pertains to the same type as hudsonite; Dana's formula equals† $(si_{24}al_4)O_{28}$, $(Fe_4Ca_3Mg_7)O_{14}$, with a density 3·127, and a volume of 258·3, which gives for the formula $(si_{41}al_7)O_{48}$, $(Fe_7Ca_5Mg_{12})O_{24}$ a volume of 442·8.

* This Journal, [2] vol. ix, p. 223, and p. 429, also vol. x, p. 119.
† This Journal, [2] vol. ix, p. 231.

Hornblende represented by $\ddot{S}i_3 Mg_3 Ca$, has an equivalent of 227·74, which with a density 2·93, gives a volume of 77·7; multiplying by six, we have 466 as the volume of tremolite, with the formula $si_{54}O_{54}(Mg_{18}Ca_6)O_{24}$. The density above given is probably too low, for anthophyllite $si_{54}O_{54}$, $(Mg_{18}Fe_6)O_{24}$ with a density of 3·16 gives a volume of 447·2. Acmite belongs to the hornblende type, and is represented by $si_{54}O_{54}$, $(fe_{18}Na_6)O_{24}$, which with a density of 3·4, corresponds to a volume of 441.

For some important observations upon the association of augite and hornblende, and their intermixture with grains of chrysolite and chabazite, see Sandberger in Poggendorf's Annalen, vol. lxxxiii, p. 453.*

We subjoin in a tabular form, the formulas, densities and equivalents of the above species.

Species.	Formula.	Density.	Volume.
Glauber-salt,	$S_4Na_4O_{16}$, $H_{40}O_{40}$	1·469	438·
Borax,	$B_8Na_4O_{28}$, $H_{40}O_{40}$	1·730	441·6
Spodumene,	$si_{60}O_{60}$, $(al_{24}Li_4Na_2)O_{30}$	3·180	457·
Diopside,	$si_{52}O_{52}(Ca_{13}Mg_{13})O_{26}$	3·240	457·
Hedenbergite,	$si_{52}O_{52}(Ca_{13}Fe_{12}Mg)O_{26}$	3·500	462·
Hudsonite,	$(si_{38}al_{10})O_{48}$, $(Fe_{16}Ca_7Mn)O_{24}$	3·460	448·
Carinthite,	$(si_{41}al_7)O_{48}$, $(Fe_7Mg_{12}Ca_5)O_{24}$	3·127	442·8
Wollastonite,	$si_{44}O_{44}$, $Ca_{22}O_{22}$	2·900	446·1
Tremolite,	$si_{54}O_{54}$, $(Mg_{18}Ca_6)O_{24}$	2·930	466·
Anthophyllite,	$si_{54}O_{54}$, $(Mg_{18}Fe_6)O_{24}$	3·160	447·2
Acmite,	$si_{54}O_{54}$, $(fe_{18}Na_6)O_{24}$	3·400	441·

The formulas of spodumene, diopside, hudsonite, and wollastonite, are seen to be homologues of the first kind, and are represented by $n(si_2MO_3)$, the values of n being 30, 26, 24 and 22. The formula of diopside equals 78RO, which is equal to that of the hornblendes; if we admit that silica plays the same double part as alumina, the formula of hornblende may be written $si_{52}O_{52}$, $(si_2Mg_{13}Ca_6)O_{26}$ corresponding to diopside. In this way the formulas of the silicates may be finally reduced to homologues of the first kind, while homologies of the second kind, having regard to the distinction between silica and the bases, assume but a subordinate importance in the arrangement of allied genera.†

Dana, dividing the volume deduced from his formulas by the number of the atoms of elements, obtained quantities nearly iden-

* Cited in this Journal, [2] vol. xii, p. 389.

† Prof. E. J. Chapman, starting from the idea that Al_2O_3 replaces SiO_2, has extended the same view to other sesquioxyds, as Fe_2O_3, Mn_2O_3 etc., and thus refers Rammelsberg's crednerite $2Mn_2O_3$, $3BaO$, CuO to the augite type $2SiO_2$, $3MO$. Looking upon $3TiO_2$ as equivalent to $2SiO_2$, he reduces sphene and epidote to the same general formula. Two communications by him in the Philos. Mag. for 1852, vol. iii, pp. 141, and 270, contain many ingenious and important generalizations with regard to mineralogical classification.

tical for the pyroxenes and hornblendes, as well as for the tourmalines and many other groups of isomorphous species; the volumes thus obtained he has designated by C, the first being the A volumes.* If instead of taking the A volume, we divide the gross equivalent weights by the number of atoms, we obtain the mean equivalent weight of these atoms, and it is clear that C represents only the volume corresponding to the atoms in these isomorphous species, where the condensation is alike. The equivalent weight of silica $Si O_3$ is 46·22; this divided by four the number of atoms according to Mr. Dana's notation, gives 11·55; in the same way $Al_2 O_3 = 51·4 \div 5 = 10·3$; $Mg O = 20·36 \div 2 = 10·18$; $Ca O = 28· \div 2 = 14·$ etc.; so that in formulas made up of varying proportions of these elements, the mean equivalent weight will be nearly the same, and in isomorphous species where the density varies as the gross equivalent, the C volume will only vary as the mean equivalent. But if elements of a higher equivalent weight are introduced into the formula, the C volume is at once changed, although if the new species belong to the same crystalline type, a relation will be apparent in the A volume, to which alone any real value belongs.

The similarity in crystallization between species whose formulas differ only in the elements of water, has been pointed out by Laurent in certain salts of organic acids, and is seen in several mineral species. The chabazites, for example, give the formula $\dot{R}_3 \ddot{S}i_3, 3\ddot{A}l \ddot{S}i_2$, with 15Ḣ and 18Ḣ, while the variety ledererite of Jackson, affords according to Hayes and Rammelsberg, but 6Ḣ.† The hydrous iolites are also cases in point, as well as aspasiolite, the serpentines, and the talcs with their varying proportions of water. In the formulas of these species, water appears to replace magnesia, and Scheerer has shown that many different species may be referred to a common chemical type, by admitting 3HO to replace Mg O, and 2HO to replace Cu O, etc.‡ These cases to which he has given the name of polymeric isomorphism, are instances of the partial substitution of water for other bases, in homologous genera which differ by n MO.

He has shown from the analyses of a great number of talcose minerals, affording from four to nine per cent. of water, that by assuming 3HO to be equal to Mg O, or in other words by adding to the oxygen of the magnesian and other earthy bases, that of one-third of the water, the ratio of the sum is to the oxygen of the silica, as 4 : 9, which is that of hornblende, 24 : 54. In certain foliated talcs, the ratios of the oxygen of the silica, bases and water, are as 15 : 6 : 2.—15 : $6\frac{2}{3}$: : 9 : 4, and 15 : 8 : : 54 : 28 nearly,

* This Journal, [2] vol. ix. pp. 221 and 407, and xii, p. 204.

† See this Journal, vol. xv. p. 230.

‡ Poggendorf's Annal., vol. lxviii, p. 319, and lxxxiv, p. 321, also this Journal, vol. v. p. 381, and xiv, p. 37.

so that the formula becomes $si_{54}O_{54}(M_{21}H_7)O_{28}=82RO$, while some amorphous talcs give $si_{54}O_{54}(M_{19}H_{15})O_{34}=88RO$, or the formula of hornblende, plus 4MO and 10MO.

A talc-diallage from Presnitz affording 6·5 per cent. of water, gives according to Scheerer's view, the relation of augite, or 2 : 1; but if the water be excluded, we obtain the relation of hornblende or 9 : 4, and with the water, the formula is nearly $si_{54}O_{54}(M_{34}H_3)O_{32}=86RO$; a similar relation appears in the nephrites which Scheerer has referred to the augite type. In certain other hydrous magnesian minerals, affording from five to ten per cent. of alumina, he has endeavored to show that $3Al_2O_3$ replace $2SiO_3$, and thus deduces for the various species, between the oxygen of the silica, with that of two-thirds of the alumina, and the oxygens of the protoxyds with that of one-third of the water, a ratio of 2 . 1. But it will be found that his analyses admit of a simpler interpretation; if we conceive al O to replace si O, as in hudsonite and carinthite, we obtain, for all the aluminous species which he has referred to the augite type, (with but one exception,) a ratio between the sum of the oxygen of the silica and alumina on the one hand, and the oxygen of the protoxyd bases on the other, (that of the water being excluded,) of 9 : 4, while the oxygen of the water is equal either to 1 or 2, so that the formulas may be written $(si\ al)_{54}O_{51}$, $M_{24}O_{24}$ *plus* 6HO, and 12HO, = 84RO and 90RO. A diopside from Reichenstein affording 1·10 of alumina and 1·9 of water, is the exception referred to, and is an aluminous augite, *plus* water.

Without having considered the densities of these minerals, we give the above formulas as representing the general type, although perhaps not the real equivalents of the species.

We now proceed to examine a number of isomorphous species, some of which will serve to illustrate the question of hydrous silicates. The arragonite group and the species which Rose has compared with it, crystallize in right rhombic prisms, in which the angle M : M varies from 112° 6′ in bournonite to 119° in nitre. Mr. Dana has pointed out another isomorphous trimetric group, having for the same prism 119°–120°. They are epsom-salt, chrysolite, picrosmine, serpentine, villarsite, and chrysoberyl, to which last he has compared the crystallization of topaz. We add iolite and aspasiolite, without knowing any determination of the vertical axes of these species.

Epsom-salt is generally written SO_3, MgO, 7HO, and with a density of 1·689 (P. and Joule) gives 73·3 for its equivalent volume; the formula $S_7Mg_7O_{28}$, 49HO, will then correspond to a volume of 513, while the higher density 1·75 which has been assigned to it gives 492. The formula of chrysolite $(\dot{M}g\,\dot{F}e)_3\ddot{S}i$, may be multiplied by four, and the analyses of many specimens then lead to the formula $si_{48}O_{48}(Mg_{43}Fe_5)O_{48}$, which gives

with a density of 3·5, 512·8 for the equivalent volume. Picrosmine, $2(\dot{Mg}^3\ddot{Si}^2)+3HO$ corresponds to the formula $si_{48}O_{48}(Mg_{24}H_{12})O_{36}$, differing from chrysolite by 12MO, and gives with a density of 2·68 a volume of 500·4. Serpentine, $2\dot{M}g_3\ddot{S}i_2, 3MgH$, multiplied by three becomes $si_{36}O_{36}(Mg_{27}H_{18})O_{45}$, which with a density of 2·55 gives 496·5 for the volume. Villarsite, $4\dot{M}_3\ddot{S}i+3\dot{F}$ becomes $si_{35}O_{36}(Mg_{33}Fe_2MnH_9)O_{45}$, and with the assigned density of 2·975 gives a volume of 475·8.

Chrysoberyl, $Be\ddot{A}l = Be\,al_3)O_4$, which with an equivalent weight of 63·98 and a density of 3·8, has a volume of 16·8; the formula $(Be_{30}al_{90})O_{120}$ gives a volume of 504. Topaz is represented, according to Forchammer, by $5\ddot{A}l\ddot{S}i+2AlF_3=(si_{15}al_{15})O_{36}+al_6F_6$. If we look upon fluorine as replacing oxygen, and raise the formula to $(si_{40}al_{56})O_{80}F_{16}=96RO$, the equivalent becomes 1748·5, which with a density of 3·65 gives a volume of 479; a colorless transparent Brazilian topaz gave me however a density of 3·57 which corresponds to a volume of 490. Andalusite is approximatively isomorphous with topaz; the formula $\ddot{A}l_3\ddot{S}i_2=(al_9si_6)O_{15}$; making it $(si_{40}al_{60})O_{100}$, we have with a density of 3·2, a volume of 497·8. The results of some analyses give the proportions of si to al, as 44 : 56, showing a partial replacement like that observed in some pyroxenes, and in the varieties of staurotide and kyanite, a consideration of whose volume and equivalents we reserve for another occasion.

The formula of iolite according to recent analyses by Scheerer, may be written $si_{45}O_{45}(al_{27}Mg_9)O_{36}$; the magnesia being sometimes in part replaced by protoxyd of iron; with (Mg_7Fe_2) and a density of 2·66, we have 515 for its equivalent volume, while the aspasiolite of Scheerer* is exactly represented by $si_{45}O_{45}(al_{27}Mg_{5\cdot5}FeH_{10\cdot5})O_{44}$, with a density of 2·764 and a volume of 506. The formulas ascribed to chlorophyllite, esmarkite and fahlunite, represent these species as iolite *plus* water, and when compared with that species are as follows:

Chlorophyllite, . . .	$si_{45}O_{45}(r_{27}R_9H_6)O_{43}$.
Esmarkite, ...	$si_{45}O_{45}(r_{27}R_9H_9)O_{45}$.
Fahlunite, ...	$si_{45}O_{45}(r_{27}R_9H_{18})O_{54}$.

The densities of these minerals vary from 2·7 to 2·9, so that their volumes will be near to that of aspasiolite; esmarkite may probably belong to the same type with that species. From the analyses of iolite it appears that it generally loses from 1 to 1·5 per cent. by ignition, and is perhaps never entirely anhydrous.

The volumes and equivalents of the above species are as follows:—

* Pogg. Annal., vol. lxviii, p. 319, and this Journal, vol. v, p. 381.

		Density.	Volume.
Epsom salt,	$S_7Mg_7O_{28}$, $H_{49}O_{49}$	1·750	492·
Chrysoberyl,	$(Be_{30}al_{30})O_{120}$	3·800	504·
Andalusite,	$(si_{40}al_{60})O_{100}$	3·300	497·8
Topaz,	$(si_{40}al_{56})O_{80}F_{16}$	3·570	490·
Chrysolite,	$si_{48}O_{48}(Mg_{43}Fe_5)O_{48}$	3·500	512·8
Picrosmine,	$si_{48}O_{48}(Mg_{24}H_{12})O_{36}$	2·680	500·4
Serpentine,	$si_{36}O_{36}(Mg_{27}H_{18})O_{45}$	2·550	496·5
Villarsite,	$si_{36}O_{36}(Mg_{33}Fe_2MnH_9)O_{45}$	2 975	475·8
Iolite,	$si_{45}O_{45}(al_{27}Mg_7Fe_2)O_{36}$	2·660	515·
Aspasiolite,	$si_{45}O_{45}(al_{27}Mg_{5\cdot5}FeH_{10\cdot5})O_{44}$	2·764	506·

Scheerer in the paper last cited, has shown that iolite and aspasiolite not only crystallize alike, but are even associated in the same crystal, one species passing into the other, and the iolite or cordierite often forming the central portions of the crystal. The formation of the hydrous species from an alteration of iolite, requires an agency which should at once remove magnesia and supply water; Scheerer from the characters of the accompanying minerals, rejects the idea of such a change, and seems to regard the association as an instance of the crystallizing together of two isomorphous species. He then alludes to the large crystals of serpentine which occur imbedded in solid ilmenite or crystalline magnesite, and associated with mica, in the gneiss of Snarum in Norway, and concludes from the absence of any appearance of change in the associated minerals, that these crystals of serpentine cannot have resulted from an alteration of chrysolite. This serpentine afforded Scheerer an amount of water corresponding to the formula given above, but G. Rose has lately described crystals from this locality which have a centre of unaltered chrysolite; one of them gave on analysis 53· per cent. of magnesia and only 4· of water, corresponding according to him to a mixture of the two species. He hence in opposition to Scheerer, Tamnau and Böbert who have examined the locality, regards these, and indeed all crystals of serpentine and the related species, as pseudomorphous.*

A glance at the formulas given above, will suggest an objection to this view. Chrysolite might be converted into picrosmine, by removing one-half of the magnesia, and partly replacing it by water, for the silica in equal volumes is the same. But if a conversion into serpentine is supposed to be effected by adding water, and removing a portion of oxyd of iron and magnesia, the 48 si O of an equivalent of chrysolite will make one and one-third equivalents of serpentine, and the volumes of the two species will be 512·8 : 662·0, or since the volumes of equivalents are theoretically identical, as 3 : 4. But neither in the magnesite and ilmenite which enclose the serpentine of Snarum, nor in any localities of crys-

* Monatsber. Berl. Akad., cited in this Jour., vol. xii, [2] p. 315.

tallized serpentines or of interstratified masses of this mineral, as far as I am aware, have there been observed any marks of the disruption, displacement, and other mechanical effects which should result from such a great increase in volume.

The advocates of this hypothesis as to the origin of serpentine, will scarcely maintain that the action in this case is different from that which should produce aspasiolite from iolite, or imagine a removal of both silica and magnesia from part of a crystal of chrysolite, while the surrounding silicates and carbonate of magnesia are like the remainder of the crystal, unaltered. The generally admitted notions of pseudomorphism seem to have originated in a too exclusive plutonism, and require such varied hypotheses to explain the different cases, that we are led to search for some more simple explanation, and to find it in many instances, in the association and crystallizing together of homologous and isomorphous species.

We have in these pages given the first series of illustrations of our views respecting the homologies of chemical formulas, and the similarity of volume in isomorphous species; it is believed that these views will be found to enlarge and simplify the plan of chemical science, and lead to a correct mineralogical system.

Montreal, Canada, June 21st, 1853.

ART. XXIII.—*Theoretic Determination of the Expenditure of Heat in the Hot-air Engine;* by F. A. P. BARNARD, Professor of Chemistry and Natural History, in the University of Alabama.

So much has been vaguely and variously said of late, in the magazines and journals of the day, in regard to the economy of heat which is claimed to be one of the great merits of the engine invented by Captain Ericsson, as to render an examination of the question, what is the true expenditure required to keep up the action of the engine, worth attempting. The confusion of thought which appears to prevail on the subject, is probably in a great degree owing to the fact, that the theory of heat, in its relations to force, has recently undergone a great and important change; so that men, who argue from its doctrines as taught twenty years ago, are liable to commit the most serious errors.

According to the theory then received, power was regarded as an accidental concomitant of heat, and not as a tax upon it. It was therefore believed that air which has undergone expansion by heat, while under a constant pressure, retains, at the end of the time, all the heat which has been imparted to it during the expansion. It would follow as a corrollary, that, if such air could

be passed through a contrivance for accomplishing *perfectly* the purpose for which Ericsson's regenerators are intended, it would deposit there all the heat it had received. And if, as is the case with the Ericsson engines, the contrivance should fall short of being perfect, in so far that the escaping air should be sensibly warmer than it originally was, the thermometer might be appealed to as a just measure of the amount of heat lost. Captain Ericsson has been understood by most persons to hold this doctrine; whether justly or not, the present writer, having met with nothing on the subject published with his explicit sanction, is unable to say.* Whatever may be his own views, however, reporters who have heard him and friends who speak for him, have so expressed themselves, as to leave no doubt that they so understand him. To such persons a curious practical paradox may be proposed, for which they would find it difficult to account, as follows:

Suppose an engine to be constructed on Ericsson's plan; but with a supply of cylinder equal to the working cylinder. Suppose, furthermore, that the condensed air, on its way from the supply cylinder to the working cylinder, should be made to pass through a refrigerator, which we will also suppose to have the power to do its work so effectually, that the air, at the moment of entering the regenerator from the reservoir, shall be reduced in temperature to a perfect equality with the surrounding atmosphere. In addition to this, we will suppose that the regenerators have power to effect perfectly the object for which they are intended; that is, to impart to the air the maximum temperature employed in working the engine, and to absorb from the same air, as it escapes, all the sensible heat it holds, above the temperature of the external air. Finally, we will make such other suppositions as are usual in theoretic abstractions, viz., that losses and drawbacks from accidental causes, (in this case, losses by radiation and conduction, or by leakage of the heated air,) are all zero. The working and supply cylinders being equal, it is manifest that the initial and final densities of the air must be equal also.

Now, at the completion of the stroke, the cylinder will be full of air of density $=1$ and temperature, say 450° F. above that of melting ice, or 32°. This air, being permitted to escape through the regenerator, returns to the atmosphere at density $=1$,† as before, but at the temperature of the weather, say 60° F., or 28° above melting ice; having left the difference $=422°$ in the regenerator. The persons who apparently speak for Capt. Ericsson

* Since this was written, an article by Capt. Ericsson, published in Appleton's Mechanics' Magazine for June, has come under the eye of the writer. It leaves no doubt that Capt. Ericsson's views have been correctly represented in the publications which have heretofore been made, on his behalf, though not avowedly by his authority.

† It is usual to put 1 = density at 32°, under pressure of 30 inches of mercury. For our present purposes, it is more convenient to make the density at 60° = unity, modifying the co-efficient of expansion, as explained further on.

on this subject, would of course expect that the next charge of air from the reservoir, taking up these 422°, would, in like manner as the former, lift the piston completely up, exerting precisely the same pressure as before, and filling the cylinder once more with air at the temperature of 450°. And they would expect to see this operation again and again repeated; so that, accidental losses being excluded by the supposition, the furnace would be unnecessay. And indeed, the only use of the furnace in the *practical* case, would, in their view, be, to repair the waste of heat resulting from imperfect insulation, from leakage, and from the necessary incompleteness of transfer in the regenerator. Such persons would therefore be probably surprised to find, that the second charge would not maintain the temperature of 450° to the end of the stroke, that the third charge would fall off in temperature still more than the second, and so on till the regenerator should be completely cooled down. But what would perhaps occasion even greater surprise than this, would be the fact, that, if a second charge of air should be drawn through the same regenerator not from the reservoir, but *from the supply cylinder directly*, the machine not now being self-acting, but being moved by some external force, this second charge, at the end of the stroke *would* have the full temperature of 450°, and (the other suppositions remaining,) would, in escaping, deposit its 422° of acquired heat in the regenerator; which would again heat the next charge to 450°, and so on *ad infinitum*. To this paradox the old philosophy furnished no key. The initial and final densities and bulks of the air in both cases are identical; and in both cases the same amount of matter is exposed for the same time to the same source of heat. But the second process is attended with no diminution of the stock of heat originally supposed to be in the regenerator, while the first is rapidly exhaustive. How shall the difference be accounted for?

An apology may perhaps be due to many of the readers of this journal for occupying space with an explanation which few of them require. Still there are no doubt some whom such an explanation will gratify, and this is the reason for presenting one, in a concise form, here.

The specific heat of gaseous bodies is not the same when they are allowed to expand under an unvarying pressure, and when confined to a constant bulk. That is to say, it requires a larger amount of caloric (measured by consumption of fuel, or in any other proper mode) applied to a given mass of air, to cause it to affect a thermometer to a definite extent, (say 1°,) when free to expand, as in a cylinder closed by an air-tight piston without friction, and when prevented from expanding, as in a similar cylinder, the piston being immoveable. Mr. Regnault has, moreover, recently proved, in contradiction to the previously received opinion, that the specific heat of air, whether at constant pressure

or at constant volume, is the same for all densities between 1 and 10; and for all temperatures between — 30° and + 225°, centigrade (− 22° and +437° F.);* so that, for all the purposes of this inquiry, we may regard this element as invariable, even if it should not prove to be so under all possible circumstances.

Now, in the case presented in our paradox, the air, at the end of the stroke, is under a pressure easily determinable by the following formula,

$$p' = p(1+\alpha\theta)\varrho,$$

In which p' represents the pressure sought, p the normal atmospheric pressure, 15 lbs. per sq. inch, θ = the temperature above melting ice, in degrees Fah., ϱ = the density of the atmospheric air at the time, and $\alpha = \frac{1}{491}$ (the co-efficient of expansion per degree F., according to Regnault, to be applied to the volume at 32° F.) If, to simplify the matter, we make $\varrho = 1$, then α will become at the assumed weather temperature of 60° F. = $\frac{1}{519} = \frac{1}{491+28}$; and θ must be reckoned from 60° upwards, instead of from 32°. Its value at the end of the stroke, according to our former assumption, is 422°. Hence $p' = 27{\cdot}2$ lbs. per sq. inch, or 1·813 atmospheres.

But, as the air of the reservoir, at the temperature of 60°, when $\theta = 0$, has the same elastic force, its *density* must, by the same formula, be now = 1·813. From this density to density 1, therefore, it is expanded by 422° of heat, under constant pressure. Now the ratio of the specific heat of air at constant pressure to that at constant volume, is, according to a mean of values given by Poisson, about 1·36.† If therefore the air had been heated

* Comptes Rendus, Apr. 18, 1853.

† This is the mean, or about the mean, of two values given by Poisson. But Poisson gives also 1·421, as a value determined by Dulong for air perfectly dry, and he also gives 1·4061, as a value determined by direct observation on the velocity of sound, by the commissioners of the French Bureau of longitude.

Major Barnard, in an article published in Appleton's Mechanics' Magazine, for July, and received since the present article was prepared, adopts the value 1·324, determined experimentally by Mr. Petrie. On the other hand, Mr. Rankine in the Lond. Phil. Mag., for June, and supplement for the same month, gives 1·40, and 1·41, as the limits which contain the true value, and 1·4094 as the value determined by observation on the velocity of sound. Poisson inclines to the largest of all the values, (1·421), on the ground that observations on sound, are liable to give the value too small, in consequence of fluctuations in the quantity of heat contained in the air undergoing compression and dilatation.

With the increase of γ, both the positive and the negative terms of pressure in the air engine are increased; but the advantage is on the whole on the positive side. Thus, if we adopt 1·324, instead of 1·36, we lose above 7 per cent. of *available* power —that is, power over and above resistance. If we adopt 1·4094, we shall gain nearly 11 per cent. of available power. The value first introduced into the text is allowed to stand, though perhaps the weight of authority is in favor of a higher number.

The foregoing observations (as to the effect of a variation of γ upon working power) are however founded on the supposition that the mechanical equivalent of a unit of

without enlargement of bulk, the same amount of caloric would have raised its temperature as much more than 422°, as 1·36 is greater than 1, that is, 573°·92. But as, at the end of the stroke its temperature is but 422° above that of the weather, it can give up only the 422° as it escapes. The difference =151°·92 has apparently been annihilated; but it has actually been converted into expansive power, and is irrecoverable.

In saying that it is irrecoverable, however, nothing more is meant than that it is utterly lost to any useful mechanical purpose. But, by undoing the work which this heat has done, that is, by forcing down the piston upon the confined air until we have expanded as much labor as has been accomplished by it—we may elevate the temperature by an amount corresponding to the seeming loss. It is hardly necessary to say, that this amount of heat will be developed, before the density shall have been reduced to that of the reservoir, 1·813, because the pressure in this reverse stroke is not constant, but rapidly rises, on account not only of the increase of density, but because of the developed heat itself.

In this case there is a seeming as if we recovered the 151°·92 degrees of heat which on our supposition had been imparted to the air by the regenerator, and had become insensible. But had the cylinder been filled with air from the atmosphere, and not from the reservoir, and had this air at density 1, been heated 422° as before, it would still yield to the same compression, precisely as large an increment of heat, as in the other case; although, this time, it would have absorbed in truth only the 422° which it seemed to absorb. The fact is, that, in both cases, the rise of temperature is an effect of labor converted into heat; as in the first case, heat is converted into labor.

We can easily understand, now, why, if a charge of air be supposed to pass through the regenerator into the working cylinder, directly from the (equal) supply cylinder, the whole amount of

heat is an invariable quantity, independent of the form of matter through which it is exerted; and, in elastic fluids, independent of the ratio between the two specific heats. A consideration of Poisson's formula (1) nevertheless shows that, p' and p being taken constant, and ϱ made =1, the value of ϱ' will be greater as γ is less. And in the general formula,

$$p'=p(1+\alpha\theta)\rho$$

It is evident that, p' and p being constant, as before, ϑ must be less as ϱ is greater. But the labor of compression, by which p is raised to p', will be greater as ϱ is greater, that is, as γ is less. Hence, to assume that γ is less is to assume implicitly that a greater amount of labor is represented by a less amount of developed heat; or, to vary γ is to vary the mechanical equivalent of a unit of heat applied to air. This consideration more than countervails the former, and leads to the theoretical result, that to diminish γ is rather to increase than diminish the working power, while it does really diminish the number of units of heat converted into labor.

And from this, we may further add, it incidentally appears, that an accurate experimental determination of the mechanical equivalent of a unit of heat applied to air, may lead, through Poisson's formula, directly to the true value of γ; and *e. v.*, that a correct independent determination of γ, should furnish, through the same, the true mechanical equivalent of heat.

heat which it receives will be faithfully returned again as it escapes. It is now heated without undergoing enlargement of bulk, and it absorbs neither more nor less heat than the denser charge would absorb, were it heated just as many degrees by the thermometer, without being permitted to expand—without being allowed, that is, to do any work, for heat, it is now well settled, will no more perform its labor *gratis*, than any other known power.

The expenditure of heat, therefore, absolutely necessary to the working of one of Ericsson's engines, in which the supply and working cylinders are equal, and no cut-off is used, in which no heat is consumed but in working, and in which the air is cooled, between the supply and working cylinders, down to the weather temperature, assumed at 60° F., will be in a general expression,

$$(\mathrm{T}-\theta)\,(\gamma-1)\,\mathrm{MK_v} \qquad \text{(I)}$$

In which T is the temperature of the air in the working cylinder, θ, that of the weather, γ, the ratio of the specific heat of air at constant pressure to that at constant volume, M the mass of air heated; and $\mathrm{K_v}$, the symbol employed by Mr. Rankine to express the mechanical equivalent of the specific heat of air at constant volume.*

But as, in point of fact, the temperature of the reservoir is not kept down to that of the weather, but is a value, say θ', due to compression in the supply cylinder, so the change of temperature in passing into the working cylinder is less: being $\mathrm{T}-\theta'$, instead of $\mathrm{T}-\theta$. Hence, the heat expended in working will be really, expressed in mechanical equivalents,

$$(\mathrm{T}-\theta')\,(\gamma-1)\,\mathrm{MK_v} \qquad \text{(II)}$$

An engine of this kind would be immensely powerful, but for the fact that a large amount of the heat which it thus consumes is employed in compressing air to feed itself. If the compressed air were allowed to expand against the piston, without receiving any additional heat, it is capable of exerting precisely as much power as has been employed in compressing it; so that, if this power could be all effectually applied, it would be just adequate to the compression of a new charge, and both power and resistance might be accounted zero. But it must not hence be inferred that all the heat derived from the furnace, and consumed in working, is therefore converted into available power; for just in proportion as the air remains heated above the temperature of the weather, at the close of the stroke, in the same proportion it is impossible for the heat developed by compression to reëxpend itself in expansion; and to that extent it must prove a dead loss, unless it can be saved by the regenerator.

* We refer this symbol here, however, to the degree Fah, and not the degree centigrade.

But the temperature of the regenerator can never be lower than that of the blast which cools it, that is to say, of the air of the reservoir. And hence it follows, as a necessity of the case, that the heat of compression must be unavailable; and that the furnace must furnish the power necessary to compress the air, as well as to do the work of the engine. The amount of heat thus unprofitably spent, depends on the degree of compression which the air has undergone, which last is determinable by the following formula of Poisson:

$$(p' = p \left(\frac{\varrho'}{\varrho}\right)^{\gamma} \qquad (1)$$

In which p', p, ϱ and γ are used as before; and ϱ' is the density due to the compression. In the present case, ϱ' is found to be $=1{\cdot}5489=1{\cdot}55$ nearly.

The temperature of the compressed air is determined by the following, in which it is represented by θ', Θ being the number of degrees required to double the volume, at 32° original temperature.

$$\theta' = (\Theta+\theta)\left(\frac{\varrho'}{\varrho}\right)^{\gamma-1} - \Theta \qquad (2)$$

Putting $\Theta=491$, according to Regnault, we shall have $\theta'=116°{\cdot}54$ $=88°{\cdot}54$ above the original temperature. To this extent, therefore, the regenerator must fail, even if supposed perfect, to absorb the 422° of sensible heat which the air contains at the end of the stroke. The difference, $333°{\cdot}46$, is the limit of possible economy to be secured by the use of this contrivance. Now expression (II) with the substitution of the value of θ' here obtained, gives us, as the total amount of heat converted into power,

$$120{\cdot}0456\ \mathrm{MK_v}$$

of which, is balanced by the waste heat developed by unavailable labor,

$$88{\cdot}54\ \mathrm{MK_v}$$

reducing the mechanical power actually developed to an available amount of

$$31{\cdot}5\ \mathrm{MK_v}.$$

But, as this waste is unavoidable, we are obliged, in instituting a comparison between the power necessarily expended, and the effect produced, to regard the engine as debtor to the entire amount of $120\ \mathrm{MK_v}$, while we credit it with the available power as computed by the formulæ laid down in another article in this Journal.

Now

$$120{\cdot}0456\ \mathrm{MK_v} = 88{\cdot}2688\ \mathrm{MK_p},$$

in which $\mathrm{K_p}$ is the mechanical equivalent of the specific heat of air at constant pressure. And, as ·2376 is (according to Regnault's most recent determination) the specific heat of air at constant pressure, that of water being taken as unity,

$$88{\cdot}2688 \times {\cdot}2376 = 20{\cdot}97\ \mathrm{MK_w}$$

expresses the positive power developed by the engine in mechanical equivalents of the specific heat of water. In other words,

every pound of air receives an amount of heat which it does not afterward restore, sufficient to raise the temperature of a pound of water 20°·97 F. But a cylinder 22100 sq. inches base and 72 inches altitude, will contain about 70 lbs. of air of ordinary density. Hence, the unavoidable expenditure of heat at every stroke of a hot air engine, having such a supply as well as working cylinder, and working without cut-off, will be $=20°·97\times70$ applied to one pound of water $=1470°$, nearly.

To convert water into steam at 212° requires, at the usual estimate, 1142°. And $\frac{1470}{1142}=1·287$ lbs. According to Bourne's tables, the mechanical effect of one cubic inch of water converted into steam at 212°, is equal to 2083 pounds raised one foot. And 1·287 lbs. = 35·58 cubic inches, similarly converted into steam at 212°, are equivalent to 74100 pounds raised one foot, or 12075 pounds raised through a six foot stroke. But we have seen in the article already mentioned, that the effect of a hot air engine, with supply and working cylinders equal, and pistons of 22100 sq. inches, is equal to 56400 lbs. during the stroke. The advantage is in favor of the heated air, to the extent of 1 : 4·63.*

If we take the properties of Ericsson's engines—that is, make the supply cylinder two-thirds of the working cylinder in capacity, we shall have, provided we put the cut-off at two-thirds the stroke, for every unit of weight of the air employed, the same number of units of heat, as before, at the moment of cut-off; but, in consequence of the subsequent expansion, there will be an ad-

* Capt. Ericsson, in his article alluded to in a previous note, expresses great contempt for the absurdity of the idea of employing supply cylinders equal to the working cylinders. But the reason assigned by him in proof of the absurdity is a little curious. He says that, in this way, something more than 1000 horse power is thrown away, by turning the air adrift while at the pressure of 12 pounds above the atmosphere, "*after that pressure had been obtained at the expenditure of force and fuel.*" Now, if the regenerator is capable of taking back the heat still unconsumed at the end of the stroke, it is a benefit, though Captain Ericsson cannot see it, to "turn the air adrift" at the highest possible pressure; or, in other words, to carry the maximum pressure to the end of the stroke: and the comparison which presently follows above, sufficiently shows, that, by so doing, the power developed is greater in proportion to the heat consumed, than when a less supply is used and the air is worked expansively. But in Capt. Ericsson's engines, the absurdity of a supply equal to the working cylinder, consists in the fact, that the effective power is absolutely zero throughout nearly two-thirds of the stroke, though working without cut-off; and that a cut-off creates a negative pressure at the close of the stroke, when the mate engine is itself powerless or worse. These difficulties are removed by the plan recommended in another article of the present writer in this Journal.

The absurdity discovered by Captain Ericsson is one of his own invention. He speaks of heated air precisely as if it were so much steam. And because steam cannot be turned adrift without carrying with it all its heat, he quite forgets his regenerators, and the purpose for which they are intended. His error, is explained, however, the moment we recognize his more radical theoretic error, viz: that the elastic force in air which is due to density, is something so independent of heat, though varying with temperature, that *it may be worked off without any expenditure of heat at all.*

ditional consumption of heat, with corresponding depression of temperature. The expression,

$$120{\cdot}0456\,MK_v = 20{\cdot}97\,MK_w,$$

M being equal to 47 lbs. instead of 70, will give us only 986° F. applied to one pound of water. But the subsequent expansion, according to Poisson's formula, (2,) will give a temperature of 322° at the end of the stroke, which is a falling off of 128, from the maximum, 450°. This is converted into mechanical effect, and this the regenerator cannot save.*

$$128\,MK_v = 94{\cdot}44\,MK_p = 22{\cdot}44\,MK_w.$$

Hence, owing to the expansion after cut-off, there is an additional consumption of heat at every stroke sufficient to raise the temperature of a pound of water, $22°{\cdot}44 \times 47 = 1054°{\cdot}68$. This amount added to the former gives $2040°{\cdot}68$. But $\frac{2040{\cdot}68}{1142} = 1{\cdot}787$ lbs. of water $= 49{\cdot}41$ cubic inches, which, converted into steam at 212°, is adequate to raise 102914 lbs. one foot, or 17152 pounds through the six foot stroke. But we have seen that the power of the hot air engine, of the proportions and dimensions supposed, is represented by 74698 pounds raised through the same distance, which makes the advantage in favor of air, as 1 : 4·35. If we allow to the steam the benefit of the same amount of expansion, its effect will be (assuming γ for steam to be the same as for air,) equal to 23050 lbs. during the stroke,† reducing the foregoing ratio to 1 : 3·24.

But it has been shown, in the article before alluded to, that these are not the proportions most favorable to the efficiency of the air engine. If $1 : m$ represent the ratio of capacities of working and supply cylinder, and $1 : l$ be the ratio of the full stroke to the fractional part up to cut-off, then $\frac{m}{l}$ should be greater than unity.

This proposition will, however, be understood to be asserted only in reference to the theoretic consumption of heat, as compared with the power developed, and to the amount of available power to be obtained from a working cylinder of definite dimensions. It is entirely independent of the question as to what volume of air can be heated by the furnace and regenerators, so as

* Capt. Ericsson says that the furnace will prevent this depression of temperature. If it does, (which is no doubt impossible, however,) the power of the engine will be greater, but the expenditure of heat will be greater also. In the present case, it will amount to 174°, instead of 128°. It would be folly, however, to introduce the former number into the calculation, since the maximum temperature cannot possibly be sustained during the expansion. The furnaces may, nevertheless, somewhat check the depression.

† Determined by the method given in a following article, and not by the imperfect modes commonly employed by engineers.

to give the best velocity to the piston. For it will be obvious that, though the theoretical consumption of heat is less when $m = 1$, than when it is less, as $\frac{2}{3}$, yet the volume of air which must be heated and cooled at every stroke is fifty per cent. greater in the former case than in the latter. Moreover, since the theoretic estimate of consumption is founded on the supposition that the regenerators fulfill their function perfectly, the practical loss of heat arising out of the imperfection of their action will be just as much greater in the first case than in the second, as the supply cylinder is larger. If there were no waste at all from this cause, then condensing cylinders of large dimensions, with supply cylinders to throw the air into the reservoir *after* condensation, as described in the following article already referred to more than once, and with $l < 1$, would furnish engines much more powerful than those of Ericsson, both absolutely and with relation to the consumption of heat.

It is no part of the present purpose to investigate the question, what would be the best theoretical proportions of the cylinders to each other, and of the cut-off to the stroke; or the numerical ratio of $l : m$, which would render the largest amount of heat available. The results of such an enquiry must always be subordinate to the experimental determination of the power of the regenerators, and the amount of waste arising from their imperfect absorption of the heat of the escaping air. In these particulars, a variation of the volume of air employed, may introduce differences which theory cannot anticipate. Leakage, moreover, may possibly be dependent, in some measure, upon the relative proportions of the cylinders. But losses from radiation, conduction, and by escape through the smoke-pipes, will not be materially different, so long as the working cylinder remains invariable in size, whatever be the magnitude of the supply cylinder.

Upon the whole, it cannot be denied that the results of theory are, in one important point of view, favorable to the hot air engine. The available power developed in this machine ought to bear a much larger ratio to the mechanical equivalent of the heat expended, than is true of the steam-engine, even when steam is worked with large expansion. But, in another point of view, the air engine is yet, even in theory, far behind the steam-engine; since, though it lays out the heat to advantage, it requires a very bulky and ponderous apparatus *to lay out the amount of heat* necessary for the creation of great power. Whether there is any escape from this difficulty is more than doubtful: but whether the evil may not be so far reduced as to render the engine an eligible motor on the ocean, for commercial purposes, if not for high speed, is a question which we are not yet justified in answering in the negative.

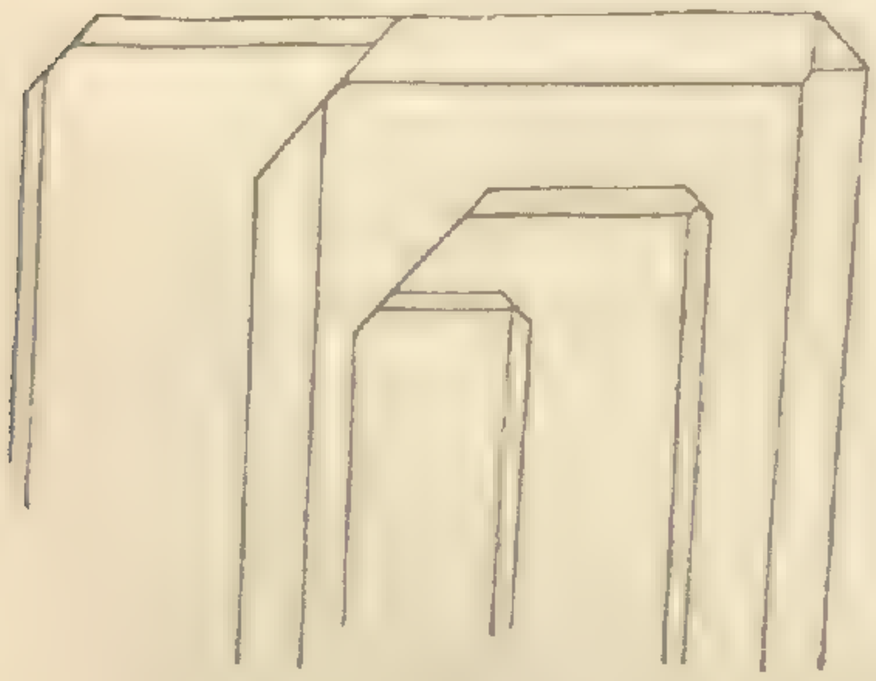
University of Alabama, July 7, 1853.

Art. XXIV.—*On the occurrence of Crystallized Carbonate of Lanthanum;* by W. P. Blake.

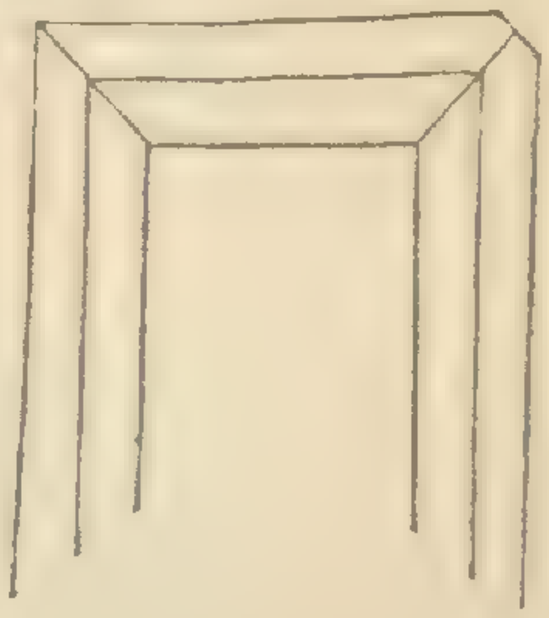
The mineral I am about to describe was found near Bethlehem, in Lehigh Co., Pa., associated with the zinc ores of the Saucon Valley. It was thrown out from a few feet below the surface, by the miners when sinking an exploring shaft near one of the veins of calamine in limestone. A single specimen of the mineral was preserved by Dr. W. W. Dickenson the superintendent, who at my request furnished me with a part of it for examination. The specimen was about three inches in diameter and attracted my attention by its delicate pink color and peculiar structure, being an aggregation of thin plates and scales of a pearly luster, forming a light reticulated mass which was found to be highly crystalline on examination by a glass, and the crystals were apparently rectangular in form. A more satisfactory examination of them was made by placing some loose fragments upon the stage of a microscope, and viewing them with a glass of moderate magnifying power. The appearance in the field of the instrument was beautiful and exceedingly interesting, each minute fragment being a part of a well formed tabular crystal, and retaining many of its edges and angles. It became evident that the angles formed by the meeting of the principal edges were oblique. Each large crystalline plate had upon its broad surface one or more smaller crystals.

Two of the forms observed are here represented.

1.



2.



The edges of all the crystals appeared to be beveled, and one or two were seen on which there was a double bevelment as represented in the second figure.

The crystals were so very thin that it was not possible to measure the inclinations of these planes.

I however obtained the angles of the tables by the aid of the rotating eye-piece micrometer attached to Nachet's large microscope. The crystal gave the angles 94° and 86°.

The measurements were repeated upon several crystals in different parts of the field with uniform results, as here given.

	I.	II.	III.	IV.	V.
Obtuse,	93° 30′	93°	94°	94°	93°
Acute,	86°–86° 30′			86°	

On examination by polarized light, the crystals were found to refract doubly.

The isolated plates or crystals appear transparent, and nearly colorless, but when the mineral is seen in mass it has a beautiful pink or rose color, and is not unlike that of peach blossoms.

The hardness is about 2 (Mohs's scale), or nearly that of gypsum.

I obtained for the specific gravity at 60° F. 2·666, which is the result of one determination only, and needs repeating, as minute parts of the light scales floated upon the water.

The reactions of the mineral before the blowpipe are as follows.

BB. In forceps—contracts greatly, whitens, becomes opaque, and when cold is brown and has a silvery lustre. Infusible.

BB. In tube, gives off water abundantly. With borax in *oxydating* flame dissolves, giving a slightly blue glass which becomes reddish on cooling, and when cold has a purple or amethystine tinge. In *reducing* flame nearly the same.

With microcosmic salt; a blue glass, while hot amethystine, and red when cold; the bead becomes opaque when but slightly heated, and retains a pink color. With carbonate of soda, a green reaction similar to that given by manganese.

The crystals dissolve rapidly in dilute chlorohydric acid, with brisk effervescence; ammonia precipitates from this solution a bulky precipitate of a delicate pink color which is insoluble in an excess of the precipitant; the filtrate leaves no residue on being evaporated to dryness.

The following are the chemical characters of the mineral as given by Prof. J. Lawrence Smith, who has kindly examined it for me.

"The mineral gives all the reactions for lanthanum and didymium, water and carbonic acid. A gentle heat expels its water. It is readily dissolved in the stronger acids with violent effervescence, and if sulphate of potash be added to the solution, a granular precipitate takes place (characters belonging to cerium lanthanum and didymium). A concentrated cold solution of the sulphate deposits on boiling small prismatic crystals, which, redissolved on the cooling of the solution, afford unmistakable evidence of the presence of sulphate of lanthanum or its like. The mineral when heated to redness loses all its water, and a large portion of carbonic acid, but it requires a long continued heat to expel the last traces; the residue is of a light brown color; if this be treated with nitric acid re-ignited and then thrown into water containing

one-hundredth part of nitric acid, it will be slowly but completely dissolved, an evidence of the absence of cerium. As to the presence of didymium, it was only indicated by the color of the oxyd; the quantity of the mineral was too small to enable me to decide in any way as to the amount of that substance mixed with the lanthanum.

A quantitative examination, in which every thing was estimated directly, gave,

Water, - - - -	24·09
Carbonic acid, - - -	22·58
Oxyd of lanthanum and didymium,	54·90
	101·57

The excess in the analysis is due to the peroxydation of a portion of the oxyds; but as we are not yet possessed of any accurate method of reducing them, the analysis must stand as it is. Other analyses were made of the separate constituents, the results of which accord with the above, and give the formula, $\dot{La}\ddot{C}+3\dot{H}$, the per-centage of which is water 25·95, carbonic acid 21·11, oxyd lanthanum 52·94 = 100·00.

This carbonate is the artificial carbonate commonly obtained by adding the alkaline carbonates to a soluble salt of lanthanum."

I have obtained the following per-centage weights, for the separate constituents.

	$\dot{La}$	$\ddot{C}$	$\ddot{C}+\dot{H}$ (by ign.)
I.	54·27	19·13	———
II.	54·93	———	45·07
III.	54·64	———	45·36

Another determination of carbonic acid gave 19·936 p. c. Subtracting the mean of the two determinations of carbonic acid from the loss by ignition gives, 25·68 per cent. as the amount of water.

These results are sufficient to show that the mineral is a simple carbonate of lanthanum with three atoms of water, and I prefer to describe it as *Lanthanite*, although its composition is very different from that given by Mosander to the mineral found at Bastnäs in Sweden, which has been examined in small quantities only, and possibly in a state of admixture, so that considerable doubt as to its constitution seems to exist; it is now important that it should receive a reëxamination as it very probably has a composition corresponding with the mineral just described.

The occurrence of carbonate of lanthanum almost chemically pure with zinc ores in limestones of silurian age, is a fact of no small interest. It should be remarked, however, that the limestones have decomposed to a considerable depth, and left the fine ore, together with peroxyd of iron and manganese, in the soil; the Lanthanite was only six feet below the surface.

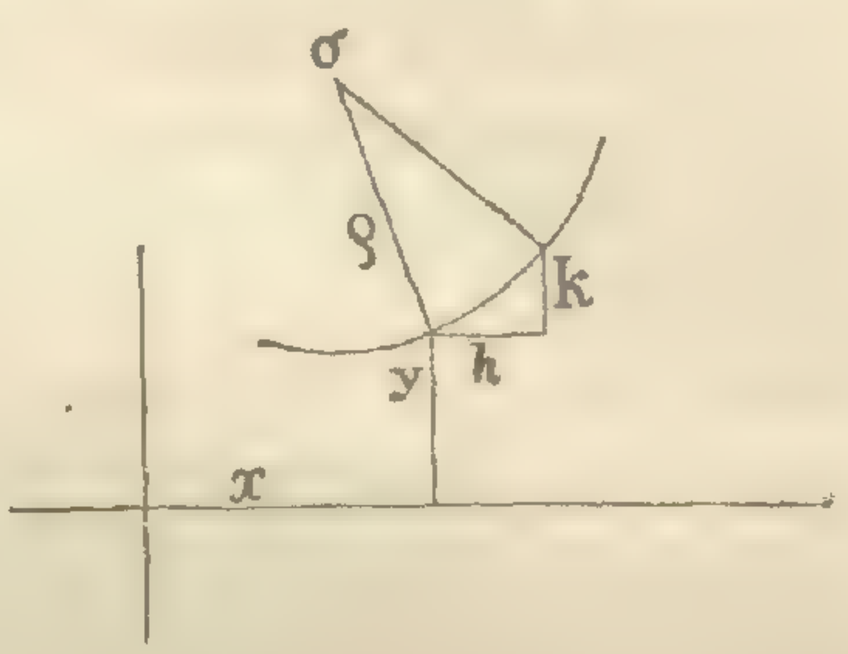
New York, March 1853.

ART. XXV.—*The Normal of Curvature;* by GEORGE CLINTON WHITLOCK, Prof. of Chem. and Nat. Hist. in Genesee College.

THE complicated method of the osculatory circle and its metaphysical difficulties, has conducted me to the following solution of the problem of curvature, founded on the natural and simple relations of intersecting normals to the arc embraced by them.

'The equation of the normal to a curve at the point (y, x), is

$$y_1 - y = -\frac{1}{y'}(x_1 - x), \quad \left[y' = \frac{dy}{dx}\right]$$



or $y'(y - y_1) = x_1 - x$,

y_1, x_1 being the co-ordinates of any point in the normal; so

$$(y+k)'(y+k-y_2) = x_2 - (x+h),$$

is the equation of the normal intersecting the curve in the point $(y+k, x+h)$. Or, for σ, the point in which the normals intersect, distinguishing the coördinates of this point by y_σ, x_σ, the equations of the normals become

$$y'(y - y_\sigma) - x_\sigma - x,$$

$$(y+k)'(y - y_\sigma) + (y+k)'k = x_\sigma - x - h;$$

$$\therefore [(y+k)' - y'](y - y_\sigma) + (y+k)'k = -h,$$

$$\text{and } \frac{(y+k)' - y'}{h}.(y - y_\sigma) + (y+k)'.\frac{k}{h} = -1;$$

from which, reducing h to zero and observing that $\left[\frac{k}{n}\right] = y'$ and

$$\left[\frac{(y+k)' - y'}{h}\right] = \left[\frac{\varphi'(x+h) - \varphi' x}{h}\right] = (\varphi' x)' = \varphi'' x, \ [y = \varphi x],$$

we have $$y''(y - y_\sigma) + y'^2 + 1 = 0,$$

or $$y_\sigma - y = \frac{y'^2 + 1}{y''}, \quad \text{and by substitution,}$$

$$x - x_\sigma = \frac{(y'^2 + 1)y'}{y''}.$$

Therefore, putting ϱ, which we denominate the "*Normal of Curvature*," for the length of the normal embraced between the point σ and the curve when $h = 0$, there results,

$$S = \sqrt{(y_\sigma - y)^2 + (x - x_\sigma)^2} = \frac{(y'^2 + 1)^{\frac{3}{2}}}{y''}.$$

It is evident that the Normal of Curvature applies much more directly and simply to the problem of central forces than does the Radius of Curvature.

Genesee College, May 7th, 1853.

ART. XXVI.—*Proposed Modification of the construction of the Ericsson Engine, with a view to increase its available power;* by FREDERICK A. P. BARNARD, Professor of Chemistry and Natural History in the University of Alabama.

The deep interest with which the public have regarded the recent attempt of Capt. Ericsson to employ the elastic force of air expanded by heat, for the propulsion of vessels at sea, appears to have given place to a feeling almost of disappointment. Whatever hopes might still have been entertained by observers whose opinions are governed by visible results only, and not by theoretic deductions, of the practicability of attaining a materially higher degree of power with greater experience, such anticipations can hardly be indulged with any confidence by those who have read with attention the searching examination of the performance of the experimental engines of the "Ericsson" ship, made by Prof. Norton, in the last number of this Journal.

If, in connection with the article of Prof. Norton, we refer to the theoretic investigation of the general question by Major Barnard, of the U. S. Engineers, in the April number of Appleton's Mechanics' Magazine, we shall be satisfied that there are difficulties in the way of increasing the efficiency of the engine in its present form, too serious to be easily surmounted. As to the fact that it has not yet been brought up nor nearly up, to the original estimate of the inventor, no doubt can possibly be entertained in any quarter.

Taking the engine in its present form, there appear to be three modes, and only three, by which its power may be increased; and all these are attended by practical disadvantages of such a nature as greatly to limit their availability. The first is, obviously, to increase its size; but, in so doing, we increase the weight proportionally, and thus unfit the engine for the uses of locomotion. The second, is to enlarge the supply cylinder only, increasing the quantity of air employed at each stroke; but this, besides requiring a similarly increased amount of fuel, necessarily increases rapidly the irregularity, or rather, inequality of action of the driving power, at different periods of the stroke. The third mode, is to diminish the fractional part of the stroke during which the air is admitted to the working cylinder, or to place the cut-off earlier in the stroke. But here a practical limit very shortly presents itself, in the occurrence of a resistance towards the close of the stroke, superior to the pressure on the working piston. With double engines connected as are those of the "Ericsson," such a resistance is not inadmissible within certain limits; because the negative pressure in either engine may be overcome by the positive power of the other; but even with such

it may easily be shown, that when the cut-off is at a little short of $\frac{2}{3}$, the driving power will be reduced nearly or quite to zero, at the points where the component of negative pressure directed against the power of the companion engine is near its maximum; and, with a two-thirds cut-off, which has been recommended by Prof. Norton, and which is larger than that sometimes or usually employed in fact on the "Ericsson," the balance of positive power at these points will become but little more than one pound to the square inch. This indeed, is true only when there is no leakage:—which, however, is simply saying that the disadvantage fails to become serious only in proportion as the advantage sought is unattained.

In speaking of the possible modes of improving the performance of the engine, it is taken for granted that the safe limits of heat have already been experimentally found; and that consequently there is no room to look for improvement in this direction. And it is also admitted that the performance of the engines of the Ericsson will very possibly and even probably, be improved, if it shall be found practicable to save the large amount of power, now evidently lost by leakage. But it seems not at all difficult to show that these engines, with their present dimensions and form, can never develop the amount of power which has been estimated for them by their ingenious inventor, even if all leakage should be stopped; unless the heat imparted to the air should be made greater than we are told it has yet been.

Whether any modification of the form of the engine can be effectual to remove the difficulties in the way of its improvement, or even partially to remove them, is a question which deserves examination. Apparently the hope of a favorable solution is not desperate; and the object of the present paper is to offer a single suggestion looking in that direction. In order that it may be intelligibly presented, it will be necessary to throw the conditions of the problem into mathematical form. The symbols employed by Maj Barnard, in the article above alluded to, will be adopted so far as they serve.

Put a = cross section of working cylinder.

ma = the same of supply cylinder.

t = the tension of the air in reservoir, when working with any adjustment of the cut-off.

t' = the same, when working without cut-off.

1 = length of stroke; l = fractional part of stroke up to cut-off.

n = ratio of expansion by heat referred to a unit-volume at the density of the air in reservoir.

15 lbs. = pressure of the atmosphere to the square inch.

1 = density of the external air, relatively to that in reservoir.

The consumption of air at each stroke, evidently equals al in bulk, it having been expanded n times by heat,

Same, reduced to density of reservoir, $=\frac{al}{n}$.

Which would fill the supply cylinder to the height, $=\frac{l}{mn}$.

Having a density $=\frac{mn}{l}$; and a tension $=\frac{15mn}{l}$.

Now, if $l=1$, or there be no cut-off, this expansion becomes $15mn$;—hence, $t'=15mn$.

But, if there is a cut-off, $t=\frac{15mn}{l}=\frac{t'}{l}$, and $t'=lt$.

If there is a cut-off, the air works by the expansion due to its natural elasticity during the remainder of the stroke, and its ultimate tension $=lt$, which, as above, $=t'$. Hence, the final tension of the air in the working-cylinder is constant, wherever the cut-off be placed, and is the same as if no cut-off were used.

From these data it is easy to find an expression for the mean effective pressure during a single stroke; this being equal to the whole upward pressure on the working piston, minus the resistances divided by the length, which is unity. This expression, reduced to its simplest form is as follows, putting P to represent the mean effective pressure during the stroke:—

$$P=15a(mn-1)+15am\,(\,(1-n)\,\mathrm{hl}\,l-\mathrm{hl}\,mn).$$

As n is necessarily greater and l less than 1, it is evident that, m and n remaining unchanged, the power will increase while l diminishes, and this without limit. A different conclusion drawn by Prof. Norton, seems to have resulted from leaving out of view a portion of the resistance.

But, while this is the mean pressure, it will be seen that the actual pressure exerted at different periods of the stroke is very variable. The maximum will occur in the beginning when the positive pressure is $=at$, and the resistance simply that of the atmosphere $=15a$. The minimum occurs at the close, when the pressure is $=at'$, and the resistances $=amt+15a\,(1-m)$. We have seen t' to be constant, m and n remaining the same, whatever may be the value of l. But t increases inversely as l, and without limit; so that $amt+15a(1-m)$ may soon be equal to, or exceed at'.

This circumstance practically restricts the power of a single pair of cylinders within a moderate limit. But when two pairs are connected as in the "Ericsson" ship, so that one may be at mid-stroke when the other is encountering the greatest resistance. each may help the other out. And this it may do, even when the resistance exceeds its own positive power at the moment;

since a large component of the resisting pressure will be thrown upon the crank and shaft. Nor is the power thus expanded by one engine to relieve the other to be regarded as a loss, since in the theoretical estimate of the power of either, the whole resistance is counted as negative.

Still the reduction of the joint power of both engines to zero, or nearly to zero, at any point, is undeniable, especially when it is considered that this is a state of things resulting from an actual increase of the mean pressure. The great evil resulting from the use of a short cut-off, is inequality of action, and the advantage of resorting to this expedient must be practically limited, unless a remedy can be found for this difficulty.

To illustrate this fact, let us take an example. Putting $m=\frac{2}{3}$, $n=2$, and $l=\frac{3}{4}$, we shall have $at'=20a$, and $amt+15a\ (1-m)$ $=22\frac{1}{9}a$; an excess of resistance nearly equal to three pounds on the square inch of the entire surface of the working cylinder. But n cannot equal 2. In practice, it will, probably, rarely exceed 1·8; and will more probably (a point to be considered further on) fall below 1·6. Put $n=1{\cdot}8$, and $l=\frac{2}{3}$. Then, $at'=18a$; and $amt+15a\ (1-m)=23a$; the resistance exceeding the power of the engine by $5a$, which, putting $a=22100$ sq. inches, as in Ericsson's engines, $=110500$ pounds.

The power of the companion engine, at this time, (taking it at mid-stroke) will be $=at=27a$; and the resistance the same as in the former case, viz. $=23a$; giving an effective pressure of only $4a$, and leaving a balance of resistance against both engines = 22100 pounds.

If we would ascertain at what point of the stroke, in either engine, working as above, equilibrium will occur between pressure and resistance, we have only to make the resistance $23a$ which is constant for more than half the stroke, equal to $\frac{t'}{x}a$; or $t'=23x$,

or $$23x=18\text{; and } x=\frac{18}{23}=\cdot78.$$

Now, if the connecting rod be not more than four times the length of the crank, we may easily show that the power of a single engine, worked as here supposed, will entirely fail, while the angle between the crank and the line of the centre, or line of neutral effect, is still more than 70°, in the pushing stroke, and not much less in the pulling. At this distance, should the companion engine be called into help, it expends a power greater than the resistance it overcomes. But as this is only the initial point of the resistance, no serious task is imposed on the companion, until the stroke is considerably farther advanced.

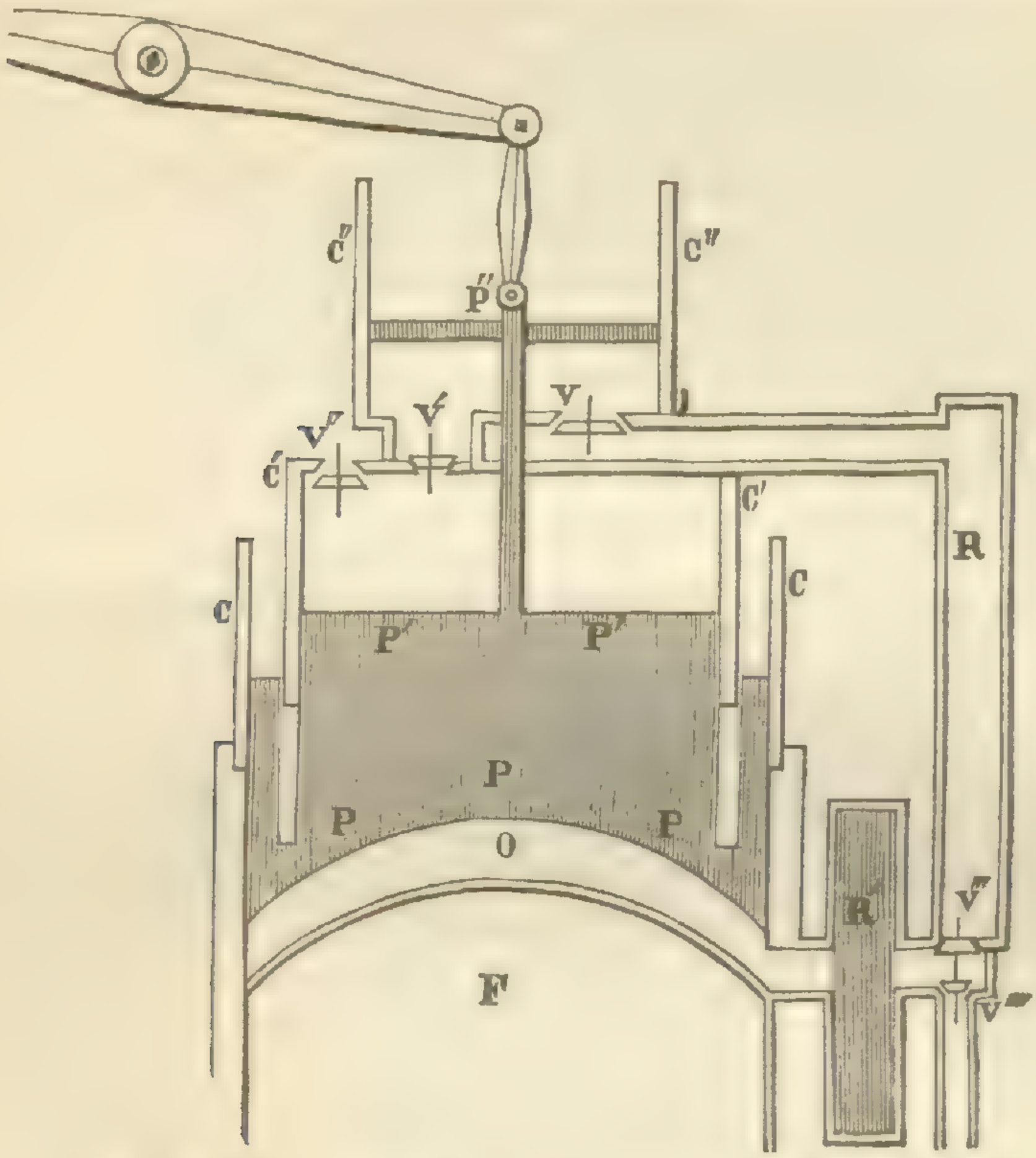
The point at which the tax upon the companion will become a maximum, will vary with the position of the cut-off, and with the proportions of the parts of the engine. In the case supposed,

it occurs between 40 and 45 degrees from the neutral line, and varies very slowly, through a considerable arc: the mechanical advantage of the driving engine increasing nearly as the resistance of the opposing. During this time, the effective pressure is reduced below 1½ pounds to the square inch. The action, therefore, of the double engine, though not entirely neutralized by this cause, is rendered very undesirably unequal.

Without going into a more minute exposition of this branch of the subject, it is the design of the present article to suggest a modification of the form of the engine, by which it is believed that the unequal action resulting from the use of high tension may be in a measure removed, so that single engines may work with larger supply cylinders, without intervals in which the power will be zero; and double engines may carry the tension of the air in the reservoir to a much higher degree than is practicable at present, without encountering the difficulties which have been mentioned.

The proposed remedy is not entirely unobjectionable itself; but it is apparently recommended by advantages more important than any objections which have yet presented themselves. And if its adoption shall render it possible to obtain as high power as has yet been reached in practice, from materially less piston surface, the most serious of these objections, which arises from an increase of the number of parts, and therefore of weight, will disappear. Possibly the modification may ultimately lead to a reduction of weight.

That the proposition may be understood, it is proper here to observe, that, at the commencement of the stroke, there is an amount of pressure which, at a high tension of the air upon these huge pistons, becomes absolutely enormous. With the tension aimed at by Ericsson, viz. 12 lbs. above the atmosphere, it becomes no less than 265000 pounds. Before the completion of the half-stroke, this is reduced to one-third of its value, when it remains constant up to the cut-off, at the two-thirds' stroke, after which it rapidly diminishes, becomes zero at eighteen twenty-thirds of the stroke, and thence finally negative to the end. The object of the modification about to be suggested, is to provide a relief for the mid stroke, and to protract, to some extent, the period of positive action, by imposing a part of the burthen of overcoming the resistance upon the earlier part of the stroke, at present comparatively free. In order to effect this object, it is proposed to employ three cylinders and three pistons where Ericsson employs only two; and to extend over a complete double stroke the labor of driving each fresh charge of air from the atmosphere into the reservoir.



CC, Working Cylinder.
C′C′, Condensing "
C″C″, Supply "
V, V′, V″, &c., Valves.
R′, Regenerator,
PPP, Working Piston Surface.
P′P′, Condensing Piston Surface.
P″, Supply Piston.
R, Reservoir,
F, Furnace.
O, Hot Air Chamber.

A reference to the accompanying diagram will explain what is meant. Let CC be the working cylinder, C′C′ a second cylinder, corresponding to Ericsson's supply cylinder, but which will here be called the condensing cylinder, and C″C″ a third, which may be called the proper supply cylinder of this proposed engine. Let P be the working surface of the large piston, P′ the condensing surface of the same piston, and P″ the supply piston.*

The air is proposed to be admitted through valves on the top of C′C′ into that cylinder, it is to be driven from that cylinder into C″C″, through valves in the bottom of it, this cylinder hav-

* To avoid giving the pile of cylinders too great altitude, it is proposed to sink the condensing cylinder considerably within the working cylinder. For this purpose a portion of the interior of Ericsson's solid pistons must be removed, and the central part made thicker, as represented. The working-beam is to be above the whole, as in Ericsson's stationary single engines, instead of being placed between the supply and working cylinder, as in the ship.

It will be observed, that by closing the top of the cylinder C″C″, and placing valves in P″, we may, if we please, cause the communication with the reservoir to be made at the top of the pile, as in the Ericsson engines. This would have the advantage of allowing larger valve space between C′C′ and C″C″; but it would require the working beam to be placed somewhat higher, which, in a ship, may be a consideration worth attending to.

ing the capacity, predetermined, to bring it to the density of the reservoir. Finally, by the descent of the piston P″, it is to be discharged through V into the reservoir, R.

No attempt will be made here to discuss difficulties of a merely mechanical nature. Some such are foreseen, and also the means of obviating them; but if the proposed modification offers a real improvement, it will be time to consider them seriously when the subject acquires a practical importance.

The disadvantages of the suggested plan are obvious at first sight; and therefore they may as well be enumerated at once, in advance. They are,

1st. A multiplication of parts, always to be avoided, if possible.

2d. An increase, to some extent, of weight.

3d. The friction of an additional piston.

The advantages are recognized only upon a more careful consideration. It will be seen, first, that the task of driving the air, after condensation, into the reservoir, is, by this arrangement, distributed equally over the entire stroke, instead of being confined, as before, to a little more than one-half of it. The total expenditure of force necessary in effecting this object, is, of course, neither increased nor diminished by the change. In the second place, the air of the condensing cylinder acquires its maximum of density only at the very termination of the stroke; and hence the maximum opposition which it offers to the motion of the piston is deferred to the latest possible moment, instead of growing up rapidly before the completion of the half stroke, as in the present engines. In all this, there is no gain of power, certainly, but there is a great gain in equality of action. It might seem, indeed, at first thought, that there is a loss of power, since the elastic force of the air undergoing condensation constitutes a resistance, according to this arrangement, throughout the entire stroke: but it will presently appear that there is a compensation for this, in the fact that this resistance is virtually exerted on only a portion of the piston P′, equal to P′ − P″. There is, in fact, no power at all absolutely gained or lost; but a great deal of power is believed to be made *available* by this construction, which could not otherwise be employed. The effective pressure will be materially reduced at the commencement of the stroke, but will be greatly increased at mid-stroke, and will be more uniformly diffused over the entire stroke, not, indeed, doing away with, but deferring, the great resistance at the close.

All this can be made to appear only by the aid of mathematical formulæ. The expression for mean pressure, though constructed upon somewhat different data from the former, assumes identically the same shape in the end, and is,

$$P = 15a\,(mn - 1) + 15am\,(\,(1 - n)\,\mathrm{hl}\,l - \mathrm{hl}\,mn)$$

If we would more particularly compare the proposed engine with that of Captain Ericsson in its present form, in regard to uniformity of action, we cannot do better than to select the points of maximum and minimum pressure in each. If the engines are double, then, when one is in the position of maximum power, the other will be at a mean, or at as near an approach to a mean, as the case admits of. We shall find that, while the plan now proposed will materially reduce the pressure at the maximum point below that of the Ericsson engines at the same point, it in so doing only reserves a large amount of force, to be subsequently expended upon a part of the stroke where the mechanical advantage attending its application is much greater. The minimum pressure in single engines, must, in the nature of things. be the same in both forms of construction; but in double engines, *the joint force of the pair* at minimum will be much superior in the form now proposed, to what it can be in the present. In comparing these joint forces, in the expressions below, they have been treated as if they were exerted in the same straight line, instead of being perpendicular to each other in mean direction. But this will not interfere with the object in view, which is merely to illustrate the difference between the two constructions, in regard to uniformity of action. The maximum pressure, in a double engine, will obviously occur when one of the pistons is commencing its stroke, the other one then in action being about at mid-stroke. In Ericsson's engines, we have seen that the effective pressure on the first may be expressed by the form,

$$P = at - 15a \qquad (i)$$

while that on the second will be,

$$P = at - amt - 15\,(1-m)\,a \qquad (ii)$$

and that on both together is,

$$P = (2-m)\,(t-15)\,a \qquad [I]$$

In order to reduce to a corresponding expression the condition of one of our proposed engines at the same moment, we must first determine the cross-section to be given to the cylinder C″C″, in order that its capacity may be just equal to the bulk of the air in C′C′, reduced to the required density. Now this bulk, being that of the constant supply, must be also equal to the constant consumption, which we have seen to be $= \frac{al}{n}$. Of two equal but dissimilar cylinders, the bases must be inversely as the altitudes. Hence,

$$1 : \frac{l}{n} :: a : m'a$$

in which m' represents the ratio of the cross-section of C″C″ to that of CC, and is obviously equal to $\frac{l}{n}$.

At the commencement of the stroke of one of the pistons, the pressure on its surface will be at, as before. But this will be opposed not only by $15a$, (the pressure on its upper surface) as in the former case, but also by that of the air in cylinder C″C″ at the other end of the working beam, whose cross-section is $\frac{l}{n}a$ and tension t. The atmospheric pressure on the upper surface of the smaller piston favors the power, so that the expression for total effect contains these four terms,

$$P = at - 15a + 15a\frac{l}{n} - at\frac{l}{n}$$

$$= 15a\left(\frac{mn-l}{l} - \frac{mn-l}{n}\right) \qquad (1)$$

For the simultaneous effective pressure upon the piston, in action in the companion engine, at mid-stroke, we have,

Pressure on under surface of working piston $= +at$

Atmospheric resistance, upper surface $= -15(1-m)a$

Resistance, partially condensed air, on P′ $= -\frac{30m^2n}{mn+l}a.$

Favoring pressure of same, on P″ $= +\frac{30lm}{mn+l}a.$

Resistance, condensed air, passing into reservoir $= -at\frac{l}{n}.$

The atmospheric pressures on the two pistons, P″, at opposite ends of the beam, balance each other.

The co-efficient of a, in the third term, $\frac{30m^2n}{mn+l}$, is obtained as follows. At mid-stroke, the undergoing condensation half fills cylinders C′C′ and C″C″. Its bulk is therefore equal to $\frac{1}{2}\left(m+\frac{l}{n}\right)a$. Let t'' = the corresponding tension, and we have

$$\frac{1}{2}\left(m+\frac{l}{n}\right)a : ma :: 15 : t'' = \frac{30mn}{mn+l}$$

which tension, acting on the surface of $P' = ma$, gives the term as above. In like manner, t'' acting on the surface, $\frac{l}{n}a$, of P″, gives the next following term.

All the expressions above, united and reduced, give

$$P = 15a\left(\frac{mn-l}{l} - 2\frac{m(mn-l)}{mn+l}\right) \qquad (2)$$

This, added to the last, gives, for the effective power of both engines,

$$P = 15a\left(2\frac{mn-l}{l} - \frac{mn-l}{n} - 2\frac{m(mn-l)}{mn+l}\right) \qquad (II)$$

Assigning now to l, m, and n, the values heretofore employed respectively, we shall find, by comparing (i) and (ii) with (1) and (2), and by comparing (I) with (II), that while the total effective pressures of both the mutually auxiliary engines, taken together, are not widely different, yet the parts which make up this total are remarkably unequal in the two cases. The substitutions of the numerical values of the letters, give the following results; a, as before, being taken at 22100 sq. in.

$$\begin{aligned}
(\text{i}) &= 12a = 265200 \text{ lbs.} \\
(1) &= 7{\cdot}555a = 166977 \text{ ``} \\
(\text{ii}) &= 4a = 88400 \text{ ``} \\
(2) &= 6{\cdot}286a = 138920 \text{ ``} \\
(\text{I}) &= 16a = 353600 \text{ ``} \\
(\text{II}) &= 13{\cdot}841a = 305897 \text{ ``}
\end{aligned}$$

It appears from these comparisons, that, at the moment of maximum joint effective action, one of the laboring pistons of Ericsson's engines is sustaining three times as great a pressure as the other; and that this is precisely the piston of which the power is applied at the greatest mechanical disadvantage. By the other construction, this inequality is much reduced. The *total* of effective action is also diminished at this point by the proposed plan; as it was designed to be, for the benefit of a later period of the stroke.

The point of maximum resistance is likewise, when a cut-off is employed, the point of minimum elasticity of the air in the working cylinder—that is to say, the end of the stroke; and this will therefore be the point of minimum joint effective pressure in the pair of engines. In Ericsson's engines, we have, for the piston finishing its stroke,

$$\text{P} = at' - mat - 15\,(1-m)\,a \qquad (\text{i}')$$

and for that at mid-stroke, as before,

$$\text{P} = at - amt - 15\,(1-m)a. \qquad (\text{ii}')$$

For an engine working without a cut-off, these expressions are obviously equal; but it is otherwise for one which works expansively.

In the newly proposed form, the expression for the first piston is exactly the same as (i′). There is no escape from the necessity of encountering somewhere a resistance equal to the full tension, t, exerted against the entire surface of the condensing piston. This, moreover, happens, when t has run down to t' in the working cylinder; that is, when the positive pressure is least. We have, therefore, for piston finishing its stroke,

$$\text{P} = at' - amt - 15(1-m)a \qquad (1')$$

And, for the piston, at mid-stroke, as before, (2)

$$\text{P} = 15a\left(\frac{mn-l}{l} - 2\frac{m(mn-l)}{mn+l}\right) \qquad (2')$$

The total of i′ and ii′, for the Ericsson engine, is, (t and t' being eliminated,)

$$P = 15a\left[\frac{mn}{l}(1+l-2m)-2(1-m)\right] \qquad (I')$$

The similar total for the other is,

$$P = 15a\left[m(n\frac{1-m}{l}-2\frac{mn-l}{mn+l}+n+1)-2\right] \qquad (II')$$

Comparing these, as before, we have,

(i′)	$= -5a = -110500$	lbs.
(1′)	$= -5a = -110500$	"
(ii′)	$= +4a = +88400$	"
(2′)	$= +6{\cdot}286a = 138920$	"
[I′]	$= -a = -22100$	"
[II′]	$= +1{\cdot}286a = +28420$	"

It thus appears, that, at the point of minimum pressure, engines constructed in the proposed form would have a considerable balance of positive power, even were their action directed in the same straight line, which it is not. In point of fact, arranged as they are, Ericsson's engines, with a cut-off at two-thirds' stroke, always preserve a balance of positive power at the point of greatest exigency; but for the same reason, the balance is much more in favor of the form now proposed, hardly descending at any time below $4a$. This estimate is founded on the supposition that the connecting rods are at least four times as long as the crank.

Since hot-air engines, not working in pairs, infallibly encounter a resistance greater than their direct positive power at the moment, whenever, working with a short cut-off, they approach the close of the stroke, the power of such engines is seriously limited. It appears that by adopting the construction here suggested, the zero point of pressure will be thrown materially later, and the limit within which the engine can be worked without encountering predominant negative pressure, will be enlarged. These are points upon which, with others, it is proposed to enter more fully hereafter, should the importance of the subject appear to justify it.

In what has been said in the present paper, no notice has been taken of the effects of leakage, of friction, or of the clearance of the cylinders. Those are matters of practical importance, but of no immediate interest in a discussion like that just now in hand.

Thus far, moreover, the proportions and dimensions of the Ericsson engines have been adopted, and a cut-off has been supposed to be placed at two-thirds of the length of the stroke. By an application of the formulæ however, it will be seen that single engines of the proposed form may be worked with much larger supply cylinders than have yet been used, with corresponding increase of power, and without negative pressure; and that double engines, by the use of a cut-off, and by working

against some negative pressure, may, with similarly enlarged supply cylinders, acquire much greater efficiency.

Without enlarging upon this point, it will be sufficient to take the expression for mean pressure already given, and substitute in it larger values for m. If $m=1$, and $l=1$, n being 1·8, as before, we shall obtain a mean pressure of 70200 lbs. and, with nine revolutions, and a 6 foot stroke, a horse-power of 230.

If l be put $=\frac{2}{3}$, m and n remaining the same, the horse-power rises to 1340. But with this adjustment, the periodical resistance becomes intolerable. Indeed, it is obvious that when m is equal to 1, no single engine can work with a cut-off at all, without a heavy fly; nor with a short cut-off, even with the aid of such a regulator. For when $m=1$ and l also $=1$, the power and resistance are exactly balanced at the end of the stroke.* But double engines may have great power, with a condensing as large as the working cylinder, and without objectionable negative pressure. Thus, put $m=1$ and $l=\frac{5}{6}$, and the horse-power of a single engine rises to 390.

The maximum effect is not attained, however, with $m=1$. The expression for mean pressure, viz.,

$$P=15a\,(mn-1)+15am\,(\,(1-n)\,\mathrm{hl}\,l-\mathrm{hl}\,mn)$$

becomes a maximum (n and l being constant) when

$$\mathrm{hl}\,m=(n-1)-\mathrm{hl}\,n+(1-n)\,\mathrm{hl}\,l.$$

Which with $n=1{\cdot}8$, and $l=1$, gives $\mathrm{hl}\,m=\cdot212214$, and $m=1{\cdot}2365$. The power increases very slowly however, with the approach to the maximum, rising (with $l=1$) only from 230 to to 254 horse-power, with an increase of the supply of air amounting to nearly 25 per cent. The question of the power of the furnace to heat this great amount of gas becomes now serious; but the more important question is the economical one; it being self-evident that the gain in power from this source, is not, beyond certain limits, a compensation for the increased amount of fuel consumed.

If, nevertheless, the form, which it has been proposed in this paper to give to the engine, be adopted. it may easily be made to appear that true economy will be consulted by enlarging the supply cylinders beyond the dimensions adopted by Ericsson. It was a part of the plan of this paper to present certain calculations upon the question of the most economical proportions. But when these are settled, (if they can be so theoretically) the important practical question remains for experimental determination. whether or not the furnaces can be made competent to supply the increased

* In Ericsson's engines, if $m=1$, the power is *zero* throughout *half the stroke*, even when working without a cut-off. In fact, this paralysis of the power exists throughout much more than half the stroke, in consequence of the heat developed by compression, as is shown further on.

demand for heat. To avoid protracting this discussion, this whole subject is reserved for future consideration.

In regard to the power actually developed by the engines of the "Ericsson" ship, it is much below what, from the data, might have been expected. The inventor was justified in believing that, with the proportions and dimensions adopted, with a heat of 480° F. or upward, and with a two-thirds' cut-off, each engine of the pair would exert a power equal to that of 300 horses. To what cause their inferior performance, is to be attributed, is not perfectly clear. It may be owing, in a measure, to a deficient heating power. It seems impossible to ascribe it wholly to leakage. It is worth consideration, whether, after all, it is not in a great degree a consequence of the expenditure of much of the force developed, upon a portion of the stroke where it acts at the highest mechanical disadvantage; and of another portion, in the mutual aid which these engines are required to furnish each other, after their power has become very much reduced, and when they are precisely in the position in which they ought to act most efficiently.

One advantage which must result from the adoption of the improvement which it is the object of this paper to propose, has not thus far been alluded to. It consists in the unintermitting and uniform flow of the supply of condensed air into the reservoir.*

As a consequence of this fact, indeed, we may be enabled to dispense with a reservoir almost entirely, without increasing the disadvantge of a perceptible fluctuation in the pressure on the working pistons.

Thus far no notice has been taken of the important fact, that the temperature of the air which is driven into the reservoir by the supply cylinder, is very materially changed by the compression to which it is subjected. This circumstance cannot but exert an important influence on the working of the engine. But as yet nothing which has been written on this subject, and which has fallen under the notice of the present writer, has touched this material point.

It is proposed, therefore, in brief, to examine the question, what should be the legitimate influence of heat developed by compression, and to modify the formulæ used in completing power, so as to allow for that influenee. Hitherto the tension of the com-

* In the reservoir of a single engine, working with a cut-off, there would still be a slight fluctuation of pressure, because the draught is intermitted, while the supply is constant. But, in double engines, employing but a single reservoir, this fluctuation will nearly disappear. It is evident that the pressure might be rendered absolutely constant, if the case required it, by means of a large piston working in a cylinder attached to the reservoir, and weighted to the exacted pressure required. A contrivance similar to this is employed to equalize the blast of tub-bellows in furnaces. For a locomotive engine, however, it would be a cumbrous and undesirable attachment.

pressed air has been inferred as if it depended upon nothing but altered density, according to the law of Mariotte. But this is to compute the power of a caloric engine, by disregarding a material part of the caloric in the case.

It is evident that, if t is the tension of the air in the reservoir, then the air in the supply cylinder will open the valves and begin to enter the reservoir (in consequence of the elasticity due to heat of compression), before the density reaches $\frac{t}{15}$. In Poisson's *Traité de Mecanique*, we find the following formula adapted to this case.

$$p' = p\left(\frac{\varrho'}{\varrho}\right)^{\gamma}, \qquad \text{(I)}$$

In which p and p', ϱ and ϱ', denote the pressures and densities of the same air before and after compression, respectively, and γ expresses the ratio between the specific heats of air at constant pressure and at constant volume. The mean of the valves given for γ by Poisson, is 1·36.*

The first consideration which presents itself, is that the elevation of temperature in the supply cylinder, (which will shortly be imparted to the reservoir,) will reduce the value of n: for n has been referred to a unit of bulk having the temperature and density of the air of the reservoir. It is evident therefore, that taking l, m and the temperature of the working cylinder as constant, the value of n will be constant also, and may be determined by the aid of the foregoing formula, suitably combined with the following, which denotes the sensible temperature of the air after the change;

$$\theta' = (\Theta + \theta)\left(\frac{\varrho'}{\varrho}\right)^{\gamma - 1} - \Theta, \qquad \text{(II)}$$

In which θ and θ' express the temperatures before and after the change of density, Θ represents the number of degrees of increase of temperarature required to double the bulk of air taken originally at the temperature of 32° Fah., (=491° F., according to Regnault,) and ϱ and ϱ' are used as before.

But, assuming these several elements to be variable, n becomes a fraction of all of them. We may find a general expression for its value, and thus, if we please, eliminate it, as follows.

* In the London and Edinburgh Phil. Mag., for June, Mr. Rankine employs 1·41 (the value of this ratio as determined from the velocity of sound,) in comparing the theoretic results of his inquiries upon the specific heat of air, with the recently published experimental determinations of Regnault. The values so closely accord, as to make it evident that this number is much nearer the truth than that employed in the text. As the present article was written, however with a view to publication in the July number of the Am. Journal of Science, the article, above alluded to had not fallen under the notice of the writer, at the time of its preparation. The computations which follow, stand as originally made, with the value of $\gamma = 1{\cdot}36$.

Put T = temperature of air in working cylinder.
θ = temperature of the weather.
θ' = temperature of air after compression by the condensing cylinder.*
Θ = number of degrees of heat required to double vol. of air, at original temperature of 32° F.
ϱ = density of the atmospheric air at the time, which may always be assumed = 1.
ϱ' = density of air in reservoir, which (ϱ being 1) we have already seen must be equal to $\frac{mn}{l}$.

Hence, (II), $\theta' = (\Theta+\theta)\left(\frac{\varrho'}{\varrho}\right)^{\gamma-1} - \Theta = (\Theta+\theta)\left(\frac{mn}{l}\right)^{\gamma-1} - \Theta$.

It is evident that,

$$n-1 = \frac{T-\theta'}{\Theta+\theta'} \text{ or } (\Theta+\theta')n - \Theta = T.$$

And
$$n = \frac{T+\Theta}{\Theta+\theta'} = \frac{(T+\Theta)l^{\gamma-1}}{(\Theta+\theta)m^{\gamma-1}n^{\gamma-1}}$$

Or
$$n^{\gamma} = \frac{(T+\Theta)l^{\gamma-1}}{(\Theta+\theta)m^{\gamma-1}} \text{ and } n = \left(\frac{T+\Theta}{\Theta+\theta}\right)^{\frac{1}{\gamma}}\left(\frac{l}{m}\right)^{\frac{\gamma-1}{\gamma}}$$

Hence, putting l and m, each $=\frac{2}{3}$, as before, assuming $\theta = 28°$ (weather temp. = 60° F.), and $T = 450°$ (being = 482° F.—as high a heat as is probably safe), we shall have $n = 1{\cdot}55$ very nearly.

Returning to equation (II) with this value of the co-efficient of expansion, we have $\theta' = 116°{\cdot}5$, or $148°{\cdot}5$ above the zero of Fahrenheit.

Equation (I) furnishes also the tension due to this value of n, which is 27·2 lbs. to the square inch.

The formula heretofore given to express the mean pressure will now no longer be applicable; since, in the construction of that formula, density was assumed as a just measure of tension. That is to say, $\frac{t'}{t}$ was put equal to $\frac{\varrho'}{\varrho}$ of Poisson's formula; whereas $\frac{t'}{t} = \left(\frac{\varrho'}{\varrho}\right)^{\gamma}$. Moreover the area of the logarithmic curve will no longer truly express the elastic force exerted by the air during expansion or compression. Instead of this we must substitute that of a different curve, whose absciss, x, is the altitude of the column of air undergoing change of density, and whose ordinate is t'', the tension corresponding to that altitude. For the positive term of variable pressure, we have the maximum tension $= t$, and by (I),

$$t'' = t\left(\frac{l}{x}\right)^{\gamma}.$$

* These temperatures are to be estimated from 32° Fahrenheit, and not from the zero of that scale.

Then, if u represent the area of the curve,

$$du=t''dx=tl^{\gamma}x^{-\gamma}dx$$

$$\int du=\frac{tl^{\gamma}}{1-\gamma}x^{1-\gamma}+\mathrm{C}.$$

But, when $x=l$, $u=o$: Hence $\mathrm{C}=-\frac{lt}{1-\gamma}$.

At the end of stroke, $x=1$; Hence,

$$u=\frac{l^{\gamma}t}{1-\gamma}-\frac{lt}{1-\gamma}=\frac{lt(l^{\gamma-1}-1)}{1-\gamma},$$

which is to be multiplied into a, the area of the working piston.

For the negative term, or that expressing the resistance of the air undergoing compression, make, x, the absciss, the supplement of the stroke, or the part of the stroke which remains at any time to be performed. Then the bulk of the partially compressed air, at that moment, will be made up of the part amx, in cylinder C′C′, and $a\frac{l}{n}(1-x)$, in cylinder C″C″; or will be a total of $\frac{a}{n}(l+(mn-l)x)$. And the corresponding density will be found from this proposition:

$$\frac{a}{n}(l+(mn-l)x):am::1:d''=\frac{mn}{l+(mn-l)x}$$

The tension, t'', corresponding to d'', will be (I),

$$t''=15\left(\frac{mn}{l+(mn-l)x}\right)^{\gamma}=15\overline{mn}^{\gamma}(l+(mn-l)x)^{-\gamma}.$$

And, as before, $du=t''dx=15\overline{mn}^{\gamma}(l+(mn-l)x)^{-\gamma}dx$

$$\int t''dx=\frac{15\overline{mn}^{\gamma}}{(1-\gamma)(mn-l)}\Big(l+(mn-l)x\Big)^{1-\gamma}+C.$$

If $x=0$, $u=0$; or $\mathrm{C}=-\frac{15\overline{mn}^{\gamma}}{(1-\gamma)(mn-l)}\times l^{1-\gamma}$

If $x=1$, the density is minimum; and then

$$u=P=\frac{15\overline{mn}^{\gamma}}{(1-\gamma)(mn-l)}(mn)^{1-\gamma}-\frac{15\overline{mn}^{\gamma}}{(1-\gamma)(mn-l)}l^{1-\gamma}$$

Or $$\mathrm{P}=\frac{15mn^{\gamma}}{(1-\gamma)(mn-l)}(\overline{mn}^{1-\gamma}-l^{1-\gamma})$$

which is to be multiplied by the difference of the surfaces P′ and P″$=ma-\frac{l}{n}a=\frac{mn-l}{n}a$, giving, finally, $\mathrm{P}=\frac{15m^{\gamma}n^{\gamma-1}}{1-\gamma}(\overline{mn}^{1-\gamma}-l^{1-\gamma})a$.

The several terms, then, which make up the mean pressure, will be as follows:

Positive pressure, before cut off $= +alt$

" " after " " $= +alt\frac{l^{\gamma-1}-1}{1-\gamma}$

Negative pressure, in supply cyl. $= -\frac{alt}{n}$

Balance, neg. pres. in cond. cyl. $= -\frac{15am^{\gamma}n^{\gamma-1}}{1-\gamma}(m^{1-\gamma}n^{1-\gamma}-l^{1-\gamma})$

Negative atmospheric pressure $= -15a(1-m)$.

Whence,

$$P=alt+alt\frac{l^{\gamma-1}-1}{1-\gamma}-\frac{alt}{n}-\frac{15am^{\gamma}n^{\gamma-1}}{1-\gamma}(m^{1-\gamma}n^{1-\gamma}-l^{1-\gamma})-15a(1-m),$$

which is the mean pressure during the stroke. By eliminating $t\left(=15\left(\frac{mn}{l}\right)^{\gamma}\right)$ and reducing, we shall have,

$$P=15a\,l^{1-\gamma}m^{\gamma}n^{\gamma-1}(n-1)+15al^{1-\gamma}m^{\gamma}n^{\gamma}\frac{l^{\gamma-1}-1}{1-\gamma}-\frac{15am^{\gamma}n^{\gamma-1}}{1-\gamma}(m^{1-\gamma}n^{1-\gamma}-l^{1-\gamma})-15a(1-m).$$

But, as we have seen that n is dependent on l and m, this symbol also must be eliminated, in order that the equation may contain only independent variables.

$n=\left(\frac{T+\Theta}{\Theta+\theta}\right)^{\frac{1}{\gamma}}\left(\frac{l}{m}\right)^{\frac{\gamma-1}{\gamma}}$. Put $\mu=\left(\frac{T+\Theta}{\Theta+\theta}\right)^{\frac{1}{\gamma}}$; and $n=\mu\left(\frac{l}{m}\right)^{\frac{\gamma-1}{\gamma}}$.

Substituting this value and reducing, the equation becomes

$$P=15a\left[l^{\frac{1-\gamma}{\gamma}}m^{\frac{2\gamma-1}{\gamma}}\mu^{\gamma-1}\left(\mu\left(\frac{l}{m}\right)^{\frac{\gamma-1}{\gamma}}-1\right)+\frac{m\mu^{\gamma}}{1-\gamma}(l^{\gamma-1}-1)-\frac{l^{\frac{(\gamma-1)^2}{\gamma}}m^{\frac{2\gamma-1}{\gamma}}\mu^{\gamma-1}}{1-\gamma}\times\right.$$
$$\left.\left(l^{\frac{-(1-\gamma)^2}{\gamma}}m^{\frac{1-\gamma}{\gamma}}\mu^{1-\gamma}-l^{1-\gamma}\right)+m-1\right]$$
$$=15a\left[l^{\frac{1-\gamma}{\gamma}}m\mu^{\gamma-1}\left(\mu l^{\frac{\gamma-1}{\gamma}}-m^{\frac{\gamma-1}{\gamma}}\right)+\frac{m\mu^{\gamma}}{1-\gamma}(l^{\gamma-1}-1)-\frac{m}{1-\gamma}\left(1-m^{\frac{\gamma-1}{\gamma}}l^{1-\gamma}\mu^{\gamma-1}\right)\right.$$
$$\left.+m-1\right]$$

This equation is too complicated to admit of a general discussion. But, by making particular suppositions in regard to m and l, it may be, in some cases, materially simplified. Thus, putting m and l each $=1$, it becomes

$$P=15a\left(\mu^{\gamma-1}(\mu-1)-\frac{1-\mu^{\gamma-1}}{1-\gamma}\right)$$

Which, substituting the numerical values of the symbols, gives $P=2{\cdot}55a=56400$ lbs.; or, with ten revolutions and a six-foot stroke, a horse power of 205.

If we make m and l equal to each other, and put a new symbol, as λ, to stand indifferently for either, the equation becomes,

$$P=15a\left[\lambda\mu^{\gamma-1}(\mu-1)+\frac{\mu\gamma(\lambda\gamma-1)}{1-\gamma}-\frac{\lambda(1-\mu^{\gamma-1})}{1-\gamma}+\lambda-1\right]$$

If, in this, we put $\lambda=\cdot8$, we shall obtain $P=3\cdot69a=81550$ lbs., or 296 horse power.

With $\lambda=\frac{2}{3}$, we have $P=3\cdot38a=74700$ lbs., or 271 horse power. It thus appears, that, when m and n are equal, the variation is slow below l or $m=\cdot8$. But the uniformity of action is in favor of the higher numbers.

In the expression above, at its maximum value,

$$\lambda=\left(\frac{\mu^{\gamma}-\mu^{\gamma-1}+1}{\mu^{\gamma}}\right)^{\frac{1}{\gamma-1}}=\cdot71226.$$

But the value of P is hardly perceptibly greater at this point, than for some distance on either side of it.

The comparison of these results, however, with those which may be obtained by making m greater than l, will show that it is not true economy to make these two numbers equal. If m be put $=\cdot75$, while l remains $=\frac{2}{3}$, the power will ascend to $4\cdot415a=$ 97570 lbs., which, supposing two revolutions and six feet stroke as before, gives a horse-power of 354. Putting $m=\cdot85$, and $l=\frac{2}{3}$, the pressure becomes $4\cdot92a=108700$ lbs. $=395$ horse-power.

Values of l and m like these cannot possibly be employed with advantage in an engine constructed on the plan of Ericsson's; since they would render the action almost spasmodic in character. and reduce the minimum power of the pair of connected engines below zero. We have seen that a cut-off was actually used in the ship, which was considerably less than $\frac{2}{3}$: but it is very evident the defects of the machinery prevented the attainment of the tension due to such a cut-off, which, therefore, failing to secure the advantage aimed at, failed also to make the evil very conspicuously manifest. But this evil is sure to occur, and is likely to interfere seriously with, if not completely to counteract, the advantages presented by this means of gaining power, just in proportion as leakage is stopped, or other causes which may keep down the tension are removed.

The construction now proposed will be, in a great manner, free from these disadvantages; and hence the powers last stated, ranging from 350 to 400, are obtainable without difficulty. Such powers are more than sufficient, according to the investigations of Prof. Norton, to make these engines available for purposes of speed in ocean navigation.

Nor are these increments of power accompanying enlargement of supply cylinder, attended with an economical disadvantage. If we compare the powers on the two suppositions, $l=\frac{2}{3}$, $m=\frac{2}{3}$, and $l=\frac{2}{3}$, $m=\frac{3}{4}$, we shall see that, while, in the latter case, the power is increased 30 per cent, the volume of air to be heated is

increased only $12\frac{1}{2}$ per cent. If $m = .85$, the increase of power is 46 per cent., while that of the volume of air is only 28 per cent. It is, nevertheless, still a question to be settled experimentally, to what extent the volume of air can be increased, without exceeding the power of the furnaces. But at any rate we are justified at present in saying, that there is no good reason, as yet, for despairing of the success of this ingenious invention.

Univ. of Alabama, June 1, 1853.

Art. XXVII.—*Note on the Parasitism of Comandra umbellata*, Nutt.; by Asa Gray.

So long ago as the year 1847, Mr. William Mitten, an English botanist, communicated to Hooker's London Journal of Botany, (vol. vi. p. 146, plate 4,) a brief article, on the economy of the roots of *Thesium linophyllum*; in which he shows that the roots of this plant are parasitic; the ramifications of the root forming attachments, by means of suckers, with the roots of adjacent plants of various species. The same parasitism probably occurs in other species of *Thesium*, if not in the genus generally. But I am not aware that the fact has been confirmed on the continental species, which are somewhat numerous, although attention has been called to the subject by the reprint of Mr. Mitten's article in the Annales des Sciences Naturelles (in the volume which bears the nominal date of 1847,) and an interesting extension was at once given to the discovery by M. Decaisne, who detected a similar parasitic attachment of the rootlets of *Melampyrum pedicularis*, and other rhinanthaceous plants long known to be uncultivable.

In the Botanical Text-Book, I had called attention to the related genus *Comandra*, which replaces *Thesium* in this country, as likely to exhibit the same parasitic economy, but, pressed by other occupations, had neglected to make the examination myself, nor had I any notice of the observation having been made by others, although *Comandra umbellata* is everywhere a common plant in the United States.

The discovery, however, has now been made by my esteemed correspondent, Mr. Jacob Stauffer, of Mount Joy, Lancaster County, Pennsylvania. He has recently sent me fresh specimens of *Comandra umbellata*, with its elongated and woody subterranean stems, giving off numerous roots, the branches of which are often expanded at their tips, into a small tubercle or sucker, which is implanted by its disk-like surface upon the bark of adjacent roots, principally of shrubs. The foster-plants, in the specimens communicated, are Blueberries and Huckleberries,

(*Vaccinium vacillans* and *Gaylussucia resinosa*). Mr. Stauffer's specimens are accompanied by a neat drawing, illustrating the mode of attachment. This I would gladly forward for the engraver: but it will suffice, perhaps, for the present to say, that the attachment is similar to that so clearly exhibited by Mr. Mitten, in the plate which accompanies his article; only that the rootlets in *Comandra* arise from subterannean stems, and the suckers so far as I have examined, do not appear to penetrate the foster root deeper than the surface of its wood.

Since the above was written and in type, I have received from Mr. Stauffer the announcement of his discovery of the parasitism of *Gerardia flava*, accompanied by a drawing which exhibits it, and a specimen which plainly shows the attachment. The numerous branches of the root are not only attached by discs or suckers to the bark of the root of the foster plant (in this case either white oak or witch hazel,) but also are implanted upon each other, forming parasitical anastomoses. I trust that Mr. Stauffer will continue these researches, and will publish the results, illustrated by his drawings.

Art. XXVIII.—*Reviews and Abstracts in Anatomy and Physiology;* by Dr. Waldo I. Burnett.

I. *Anatomy of the Nervous System of Rana pipiens.* By Jeffries Wyman, M.D. Smithsonian Contributions to Knowledge. pp. 51, 2 plates. March, 1853.

This is one of the few Monographs upon special anatomy that have appeared in this country. The Monograph belongs to the highest class of descriptive science: it is the handling of a subject in all its special details, and as though it were, at the time, *the* grand one for consideration. Philosophical science in its highest form can proceed only from scientific monographs. for the philosophical relations of any science are correctly understood only when resting on full and complete data.

Prof. Wyman's memoir contains many entirely new anatomical details, and is replete with sound, philosophical remarks on the homological and other relations of the vertebrate nervous centres.

Where there is so much worthy of special notice, we must be content to indicate a few of the principal features.

After pointing out some of the anatomical relations of the olfactory lobes, Prof. Wyman remarks:

"A condition of things rarely met with, perhaps only in a few Anourous Batrachians, is the fusion of the right and left olfactory

masses, with scarce a trace of any indication that they are double organs. . . . . This union of the olfactory lobes, however, is analogous to what occurs in the cerebral lobes of sharks and other Plagiostome fishes, and in the optic lobes of the *Lepidosiren*, and, as it seems, in *Menobranchus*. Their fusion is a subject of additional interest, since it tends to show that they are developed from a single embryonic vesicle, and not from a pair of vesicles. If this statement be true, then we have the olfactory lobes arrested in their development, previous to the division of this vesicle. An analogous state of things is easily shown in a chick of the fourth day, where the optic lobes form a single vesicle, though they subsequently become double and widely separated from each other. In *Lepidosiren*, according to Owen, there is but one optic lobe, and that on the median line; we may therefore regard this last as the vesicle undivided. The fusion, or rather the absence of separation, of the cerebral lobes of Plagiostome fishes, is undoubtedly to be explained in the same manner."—pp. 7, 8.

In speaking of the cerebral lobes, their distinct separation here is forcibly dwelt upon as an interesting anatomical feature, as connected with the complete duality of the function of these parts; and the opening through the brain downwards, which is made by the closing up of the fissure between the cerebral lobes, might seem at first comparable to the œsophageal ring of the invertebrates. Prof. Wyman here improves the excellent opportunity for some very sound remarks on the real grounds of an homology between the nervous centres of the vertebrate and articulate divisions of animals. He says:

"Although frequent attempts have been made to homologize the nervous systems of vertebrates and articulates, yet in reality there seems to exist no correct basis on which the alleged homology may rest."

After noticing the advocates of this view, and some of their grounds, he continues:

"If there be any homology, it seems to us as if the whole nervous system of the articulates, as far as it is developed, should be homologous with a corresponding portion of that of the verterbrates. If the subœsophageal ganglion is homologous with the medulla oblongata, that which follows it should be homologous with the spinal cord. . . . . If a true homology existed, we ought at least to have representatives from the articulates and vertebrates, in which the identity would be obviously proximate, if not absolute. But as yet, there has been described no instance where the spinal cord, structurally considered, is fairly and distinctly represented in the articulates, nor among vertebrates any true ganglionic chain with an œsophageal ring through which the œsophagus passes."—p. 9.

These doctrines of homology, with different divisions of the animal kingdom, demand the fullest attention from anatomists and physiologists, for our most comprehensive ideas of organization, and our highest views of the nature and permanency of grand types in animal life, depend upon our discrimination carefully between what constitutes a true homology, and what is merely a similarity of functional relations. In former times the writer, following Rathke and Geoffroy St. Hillaire, was the advocate, from embryological data, of this alleged homology between the nervous centres of these two grand divisions of the animal kingdom. Subsequently, however, extended and enlarged views of the character of grand typical forms, have shown the inadmissibility of such doctrine, and we are pleased to find here so clear an exposition of the real character of this hypothesis.*

Passing over the details of the description of the cerebral centres, and meeting our author at the cerebellum, we find some very noticeable remarks upon that disputed point, the function of this organ. He says:

"The low degree of the development of the cerebellum in frogs, naturally suggests to us an inquiry as to the nature of its functions, and likewise leads to the conclusion, that, whatever those functions are, they must, on analogical grounds, be supposed to have a low state of activity in comparison with the same organ in those animals in which it is proportionately more largely developed. The low development of this organ in frogs and cyclostome fishes is certainly at variance with either the more generally received theories entertained by physiologists of the present time; namely, those of Gall and Spurzheim on the one hand, and of Flourens on the other. It would be difficult to reconcile either of them, or perhaps any existing theory with numerous other facts afforded by comparative anatomy, all of which tend to show a vast disproportion, at least, between the size of the cerebellum and the activity of the functions of which it is alleged to be the seat. As regards the theory of sexual instinct, this function is certainly not less strongly manifested in the lamprey than in ordinary fishes, as the trout or the herring; yet how widely different is the relative size of the organ in the two."

Speaking of the theory of Flourens, Dr. Wyman says:

"His theory, that the cerebellum coördinates muscular motions, is opposed by numerous anatomical facts, as well as by some of the results of pathology; for out of *ninety-three* cases of lesions of the cerebellum, Audral found but *one* to sustain the theory of Flourens. . . . . We will take one more illustration

* It may not be out of place to mention in this connection a work which is well deserving the attention of all philosophical anatomists as to the point in question; viz., Observationes de prima Insectorum genesi adjecta articulatorum evolutionis cum vertebratorum comparatione, Diss. Inaug. By *Albert Kölliker*, Turin, 1842.

of the inconsistency of this theory (and it equally applies to that of Gall and Spurzheim) with facts; we will contrast the organ in question, as it appeared to us in the recent dissection of a porpoise (*Delphinus phocæna*) and of a shark (*Carcharias obscurus*). Both of these animals are predacious, both pursue their prey in the water, both are endowed with great rapidity of motion, both are capable of readily and suddenly changing their direction, and both move by the alternate flexion and extension of the vertebral column; I know of no reason for supposing that the power of coördination is materially different in the two; and in these instances the mass of the body was in the two nearly the same, and yet the cerebellum of the porpoise is not only relatively, but absolutely, several times larger than the whole encephalon of any other fish whatever."—pp. 13, 14.

No doctrine was ever received more kindly, or treated more justly by scientific men, than that of phrenology in its day. It is true that the pretensions and premises on which it was urged, were of a much higher character than those of other doctrines introduced to the public; but these had a speciousness, since there were arrayed for their support *some* facts in comparative anatomy, whereas the case appears quite different when *all* the facts with their relative bearings are studied. The sexual function of the cerebellum has always been considered one of the strongest points in the system of Gall; and as for the geography (so to speak) of the cerebrum, what reflective medical student is there, who has had an opportunity to open half a dozen heads and to dissect the brain, who has not seen the striking irrelevancy of the whole doctrine to facts; we refer here to the pretended organs on the brain's surface being evinced by corresponding prominences on the cranium. The allotment of certain portions of the brain for the performance of certain classes of mental action, is another thing; but even this is without that comprehensive support which could entitle it to a scientific character.

From the anatomical description of the grosser parts of the encephalon, Prof. Wyman proceeds to a consideration of the intimate anatomical structure of the brain as elucidated by microscopical inquiry. In this subject are involved points of the highest physiological import, and about which some of our best observers are very far from being agreed. As this is a subject to which the writer has paid some special attention of late, and moreover as his own results quite accord with those of Prof. Wyman, he will discuss the points freely in his own language.

Many details connected with the intimate composition of nervous tissues have long been satisfactorily settled by microscopists. It is no longer disputable as to the variety of the forms these elements take, neither is it a question as to their cell-composition. All nervous tissue has but two elements, the vesicular or genera-

tive, the tubular or conductive. The former composes the grey substance of the ganglia or nervous centres, the latter forms their medullary portion and the nerves. The question at issue of late among microscopical anatomists, is, what is the precise anatomical relationship between these two portions of nervous matter. Do the primitive nervous fibres enter the grey matter, wind about among the nerve-cells and ganglionic globules, and finally terminate in looping anastomoses, as has been advocated by our earlier observers; or do these primitive fibres terminate infundibuliform in ganglionic vesicles, as has recently been advanced by some of our best microscopical observers?

The decision of this point is important in connection with the origin and transmission of nervous force.

We will refer briefly to the historical relations of this subject. Many years since, Remak discovered in the nervous tissue, large vesicular bodies which had irregular digital prolongations. These prolongations he maintained were continuous into the grey fibres of the nervous substance. This view was soon after verified by Hannover, who after some extended research, concluded that the nervous centres contained two kinds of ganglionic vesicles, those which were simply spheroidal, and those which had processes which were continuous with the nerve fibres. Since then there have followed not a few observers with results of a similar import, and whose names we have indicated below.* Chief among these,

* For the sake of convenience of future reference, we here give the names of those observers who have studied this subject.

Remak, Observ. anat. micros. de Syst. nerv. Struct. Berlin, 1838; also in *Müller's* Arch. 1843, p. 200.

Hannover, *Müller's* Arch. 1840, p. 555; also Recherch. micr. sur le Syst. nerveux 1844, p. 69, Pl. VIII.

Helmholtz, De fabr. Syst. nerv. evertebr. Berlin, 1842, p. 10.

Will, *Müller's* Arch. 1844, p. 76.

Kölliker, Die Selbständigkeit und Abhängigkeit des sympathischen Nervensystems, 1844; also "Neurologische Bemerkungen," in *Siebold & Kölliker's*, Zeitsch. f. Zool., i, 1849, p. 175; also "Microscopische Anatomie," ii, 1850, p. 390–546.

Todd & Bowman, Physiological Anatomy, 1845, i, p. 212.

Volkmann, *Wagner's* Handwörterb. d. Phys., ii, p. 613.

Budge, *Roser* and *Wunderlich's* Vierteljahrssch. 1846, p. 347.

Hyrtl, Anatomie, p. 121.

Burdeleben, *Müller's* Arch. 1846, Jahresb. p. 84.

Schiff, *Griesinger's* Arch. 1846, p. 794.

Bendz, Almindel. Anat. p. 427.

Schwann, Ann. des Sc. Natur., 1846, vi, Pl. VI, VII.

Bidder u. Volkmann, Zur Lehre v. d. Verhältniss d. Ganglien-körper zu d. Nerven-fasern, 1847.

Reference may be also made to the following where the subject is incidentally, or in course illustrated.

Bruch, Ueber das Nervenssystem des Blutegels, in *Siebold u. Kölliker's* Zeitsch. f. Zool., i. 1849, p. 164, Taf. xii.

Leydig, Anat. Bemerk. üb. Carinaria, Firola und Amphicora, Ibid. iii, 1851, p. 325, Taf., ix. fig. 5.

Muller, Physiology, Transl. by *Jourdan*, *Littre's* Ed., Paris, 1851, i, p. 360, where also *Robin's* views are quoted.

however, as will be seen, is *Kölliker*. Judging from his statements and his still more numerous figures, there would appear no doubt that nerve-fibres may and do arise from the vesicular centres. (See especially the numerous figures in his "Mikroscopische Anatomie," ii, p. 390–546.)

After the most careful study of the intimate structure of the nervous centres of frogs, Prof. Wyman has failed to observe any thing of this direct anatomical relationship between the two portions of nervous substance. Liedy's observations on the microscopical structure of the nervous centres of the terrestrial Gasteropoda, sustain also the view of the non-direct connection. (See "The terrestrial air-breathing Mollusks of the United States, by Amos Binney. Edited by Dr. A. A. Gould. Special Anatomy, by *Leidy*, vol. i, p. 243.) To this the writer may add his own experience of the same import. He has invariably failed to detect the direct continuity of these parts, and in some special researches made sometime since on the intimate structure of the human brain, nothing of the kind warranting *Kölliker's* opinions was observed.

This discrepancy of results is not a little remarkable, and although from the character and the amount of the authority in favor of the direct connection of vesicles with nerve tubes, there can be no reasonable doubt that such relations do occur; yet it may be very justly asked if this connection when present, is not the exceptional condition, and one wholly unessential to the mutual physiological relations of the nerve-cells and nerve-tubes. If it is necesssary for the transmission of nervous power, that the nerve-tube should be directly continuous into the nerve-cell or vesicle, then it would be supposed that all nerve-fibres must terminate in this manner. This, as is well known, is not the case.

The writer has had the good fortune to be able to watch the phases of nerve formation from the earliest point to the complete condition, and it has occurred to him that these curious phenomena in question, might find some explanation in the probability of some of the old nuclei of the nerve formation, producing a cell within the confines of the nerve tube, and thus giving rise to a vesicular expansion. Some appearances have been observed rather favoring this view, but we adduce it only in a suggestive light. The whole subject deserves special attention from our best microscopical observers in anatomy.

From a consideration of the intimate structure of nervous tissue, our author passes to Section III, on the spinal cord. Space allows us to make but a single extract which we select upon a point of more general interest.

"The change of form which the spinal cord undergoes during the progress of development is one of the most interesting features, and one which long since attracted attention. The phases

are the same that are met with in other vertrebrates in which limbs are developed; but while in these the changes take place with great rapidity, in frogs generally the ichthyic condition of the cord in which there are no enlargements or bulgings, continues for several months, the eggs being hatched in the spring, and the complete development taking place in the latter part of the summer. In bull-frogs, in this latitude at least, (42° north), it took not less than a year, as the tadpoles hatched in the spring, pass the following winter in the same condition, the metamorphosis occurring during the following spring or summer.

Until the legs begin to be developed, the cord presents the form of an extremely elongated cone, and the bulgings as was noticed by Serres, are developed simultaneously with the legs. I have not, however, been able to confirm the statement made by him, and repeated by others, that the caudal portion of the cord is shortened as the legs and the bulgings are developed. According to my observations, no shortening takes place until the absorption of the tail commences, and this happens after the bulgings are formed and the legs have acquired their growth. The whole of the caudal prolongation, however, is not absorbed, a portion being persistent and eventually becoming enveloped by the elongated coccyx."—p. 21–22.

Section IV, treats of the peripheral portion of the nervous system. Here Prof. Wyman's researches have afforded results somewhat different from those of his predecessors.

The subject of the cranial nerves is, as is well known, one of the most important connected with philosophical anatomy; for upon the interpretation of these nerves, depend the various cranial theories some of which have become so noted. We cannot better present the subject than by giving Prof. Wyman's table which exhibits an enumeration of the cranial nerves of man and mammals compared with those of the frog.

"A. Cranial nerves.

Mammals.	Frog.
I. Olfactory,	I. Olfactory.
II. Optic,	II. Optic.
III. Motor communis,	III. Motor communis.
IV. Patheticus,	IV. Patheticus.
V. Trigeminus, VI. Abducens, VII. Facial,	are combined, and form V. Trigeminus.
VIII. Auditory,	VI. Auditory.
IX. Glosso-pharyngeal, X. Vagus, XI. Acessory, XII. Hypoglossal,	comb'd & form VI. Vagus.

B. Spinal nerves of the Frog.

I. Hypoglossal.		VII.	Crural.
II.	Brachial.	VIII.	
III.		IX.	
IV.	Abdominal.	X. Coccygeal.	
V.			
VI.			

From this table it will be seen that the hypoglossal nerve in the frog occupies a position somewhat anomalous, forming, as it does, the first pair of the spinal series."—p. 24.

In his description of the optic nerves, Prof. Wyman has some interesting remarks on the relations of the optic lobes to the function of vision. He says: "Many observers have shown, by dissection, that blindness of long standing is followed by atrophy of the optic lobes, (agreeably to the well-known law of atrophy following disuse), and that extensive lesions of the lobes are attended by either impairment or loss of vision. In recent dissections of frogs, similar results have been observed. One in which the *right* eye had been destroyed had atrophy of the left lobe, which was reduced by nearly one-third of the dimensions of that of the opposite side. The condition of the nerve was not examined.

In a second instance, there was blindness from destruction of the left eye, in which there was atrophy of the left nerve before decussation, of the right nerve behind the decussation, and of the right optic lobe. In neither of these cases was there any marked alteration in the proportions of the optic thalami." But he adds: "The facts furnished by comparative anatomy, however, tend to show that vision is not the sole function of the optic lobes." He then alludes to the instances of blind animals found in caverns and other dark places, in which the optic lobes are not undeveloped. But we do not recognize the correctness of this last sentence, and cannot perceive how the plural function of these lobes can be inferred from the data cited. On the other hand, considering the stability of typical forms in structure, and the unvarying relations of grand types, even in distinct systems of tissue, we should indeed not look for any deviations from these fundamental plans to fit a single condition, and especially where all the other relations of life are as usual. The doctrine of final causes, although fully sustained by the general conditions of organization as manifested under typical plans, has many an instance in living forms which would be wholly irreconcilable, did we not bear in mind its reference to a type idea. The mammary gland exists in man as well as in woman, and yet it has but one function, its presence in man being in virtue of a typical plan.

We pass over the details upon the cranial nerves contained in this section. Not a few of them are new, and the whole carried out in all their relations with an almost wonderful minuteness.

We would not omit, however, to notice the discovery which Prof. Wyman has made of a new nerve with the Batrachian reptiles. It is a nerve strictly identical with the *nervus dorsalis* of fishes. It is a branch from the *nervus lateralis* and appears to have been hitherto unnoticed. Prof. Wyman remarks:

"The observation of the existence of a dorsal nerve gives additional importance to the discovery of the nervus lateralis by Van Deen; and if to these we add those branches of the vagus described above, which pass along the branchial arches, the analogy of the larvæ of Batrachians to fishes becomes much more striking than there has been reason hitherto to regard it."—p. 37.

Section V. treats of the philosophical anatomy of the cranial nerves and skull. *Prof. Wyman* gives his preference to the three vertebræ theory of the constitution of the cranium. He says:

"If we apply the analogies of the spinal chord and vertebral column to the cranium and its nerves, we ought to base our determinations on the repetitions of true spinal nerves and of the true vertebral elements. If the theory be true which reduces the cranial nerves (exclusive of the special sense nerves) to three, namely, the trigeminus, vagus, and hypoglossus, then we ought, *à priori*, to detect at least three vertebral segments. This conclusion agrees perfectly well with the determination from osteology. . . . . These vertebræ may be designated as follows: 1st, the occipital, of which the basilar bone is the body; 2nd, the parietal, of which the posterior sphenoid is the body; 3d, the frontal, of which the anterior sphenoid is the body."—p. 41.

In concluding this section, Prof. Wyman has some very noticeable remarks on the interpretation to be given to the jaws and other bones of the face in connection with the three vertebræ theory. After alluding to the fact that the latter are strictly appendages of the mucous membrane, and that the jaws and other tooth-bearing bones, as well also as the hyoid bone, are developed in intimate relation with the alimentary canal, and that primarily the mouth and nostrils are but a single cavity, he remarks: "We have strong grounds for the hypothesis, that all the bones of the face which are developed in the walls of the primitive cavity of the mouth which they surround, are in their anatomical and physiological relations splanchnic, connected either with digestion or respiration, rather than parts of the endo-skeleton of animal life."—p. 42.

The last two sections (VI and VII) treat respectively of the spinal nerves and of the sympathetic nerve. They are full of details most interesting to the thorough anatomist; but our space will not allow us to refer to them specially. It should be mentioned, however, that Prof. Wyman has distinctly made out a coccygeal nerve, thus making the number of pairs of spinal nerves ten instead of nine, the number usually enumerated; and

also showing that the strangely shaped coccyx is a true vertebra. We have thus but imperfectly indicated the contents of the work under notice. It could scarcely be otherwise, for the various subjects in the different sections are treated so connectively from paragraph to paragraph, that full justice to the author's labor could be given only by making longer quotations than our space would admit. However, the purpose of this notice will be accomplished if we succeed in calling attention to one of the ablest of recent researches.

II. *The Hectocotylus of the Cephalopoda.*

Delle Chiaje, Memoria sulla Storia et Notomia degli animali senza vertebre del regno di Napoli, 1825, p. 223, Tav. xvi, fig. 1-2.
Cuvier, Ann. des Sc. Nat. xviii, 1829, p. 147, Pl. xi, A. fig. 1–5.
Costa, Ann. des Sc. Nat. 1837, p. 172, also Ibid. 1841, xvi, p. 184, Pl. 13, fig. 2, a–c.
Kölliker, Annals Nat. Hist., xvi, 1845, p. 414, also, Bericht von der zootomischen Anstalt zu Würtzburg, Leipzig, 1849. p. 67, Taf. i, ii; and Transact. Linn. Soc., xx, 1846. Pl. I, p. 9.
Siebold, Lehrbuch der vergleichenden Anatomie der wirbellosen Thiere. Berlin, 1848, p. 362. Also Zeitsch. für wissensch. Zool., iv, p. 122.
Power, (Madame,) Mollusques Mediterranéens. 1ere Partie. Gènes, 1847–51, p. 34, and 126. Pl. xli.
Vérany & Vogt, Ann. des Sc. Nat. xvii, 1852, p. 146. Pl. vi–ix.
H. Müller, Ann. des Sc. Nat., 1852, xvi, p. 132, Also, *in extenso* in the Zeitsch. für wissenschaftl. Zool., iv. p. 1, Taf. i, and p. 346.

The Hectocotylus is a worm-like form which is found attached like a parasite to certain forms of Cephalopoda, (*Octopus*, *Tremoctopus*, *Argonauta*.) The subject has attracted so much attention from its curious nature that I have thought best to indicate its historical relations by the above list of authors and papers. They will, moreover, serve as texts to some little account of this zoological anomaly.

These bodies in question, which are vermiform, but which resemble distinctly no animal whatever, are found attached by a sucker, in the cavity of the mantle of certain cephalopods. It is not strange that some of the observers first named should have regarded them as parasitic worms, and although presenting evidently, anomalous anatomical parts, Cuvier concluded by pronouncing it "un ver vraiment extraordinaire."

But it soon appeared as a remarkable fact that the cephalopods on which these bodies were found were invariably of a certain kind, and furthermore, that from the most careful search, no males were seen. From this, Kölliker was led to regard them as male cephalopods of a remarkable nature. This supposition was confirmed by his anatomical researches, for he showed that the structure of these forms had, in many respects the characteristics of the cephalopods alone; besides containing distinct spermatic and fecundating parts. It was then evident that these curious bodies were of a true cephalopod nature and served the function of males. But it was a question of both physiological and

zoological import, what is their individual character. Are they to be regarded as distinct animals, having an independent existence; or are they simply cephalopods in which a male apparatus is developed. The settling of this question was attended with more difficulties than would have been supposed, and it provoked the labored, accurate and detailed researches of the few last-mentioned memoirs in the preceding list. The first of these views, namely, that these forms are truly independent animals, has been supported by Kölliker, who, in a very extended memoir, has attempted to show that, having a heart with the vessels, and possessing also branchial nerves and such highly developed genital organs, they can be regarded only as distinct individuals. Moreover, he brings to the support of his view the observations of Madame Power, and of Maravigno, from which it would appear that the hectocotyli are formed within eggs, and first appear as small worms having two rows of suckers on their whole length, and a filiform appendage at one extremity, and a small enlargement at the other.

On the other hand, other and later observers support the second view, the non-independent animal character of these forms. Chief among these are H. Müller, and Vérany & Vogt, and incontrovertible as would seem at first the ground of Kölliker's opinion, they have satisfactorily shown, even to Kölliker himself,* the correctness of their position. The details of these researches by which the question seems now pretty definitely settled, the limits of these pages will not allow me to give. It may be remarked, however, that these observers have all studied these forms upon living specimens on the coast. It has been shown that the Argonauts on which these hectocotyli are found, have a highly developed testicle, the situation and structure of which correspond to those of the common cephalopods, and which communicates with the hectocotyle.

In conclusion, I may quote H. Müller's own words: "It is then proved that the hectocotylus is formed on a male argonaut, and is nothing but an arm metamorphosed in a very irregular manner. This arm, or the hectocotylus, is detached when it has been filled with the sperm which is formed in a true testicle of the argonaut itself, and it then plays an apparently independent life. In this condition, it meets the female argonauts which form a true copulation, it impregnates, as I have observed with the hectocotylus of a *Tremoctopus*, and it resembles in this, as also, by its movements, by a kind of circulation, and by the long duration of its life after detachment, a true male animal."

* See the *Nachwort*, by *Kölliker*, to the memoir by *H. Müller* in the Zeitsch. für wissenschaftl. Zool., iv, p. 35.

III. *New Muscle-element in the Thoracic Muscles of Insects.*

*Aubert** states that he has found an entirely new form of muscle-element in the *Libellulidæ;* this consists of flat, primitive, muscular bands occurring only in the thorax, and which by means of a pitcher-shaped (becherförmigen) apparatus, move the wings.

The following are his conclusions on this subject:

"1. The comparatively very large muscles of those insects which fly with a buzzing sound, separate, when fresh, into fine, transversely striated fibres.

2. The fibres are the primitive muscular fibrillæ.

3. Between the fibrillæ there is a granular mass, the use of which is unknown.

4. All other muscles when fresh present no appearances of this kind.

5. The *Libellulidæ* have in the thorax primitive muscular bands.

6. The elements of the muscles are little cakes or cylinders which are applied together, forming the fibrillæ.

7. During contraction, the fibrillæ thicken, and the striæ are approximated."

These results have been confirmed by my own experience, for the thoracic muscles of insects have long been to me beautiful objects for the study of the histological elements of muscular tissues. It is a form of this tissue particularly to be recommended for the study of the intimate sarcous elements. The fibrillæ readily separate into the discs of which they are composed, and the whole field is then filled with these last floating freely about. But it is a question if these primitive fibrillæ which are here so distinct, are not the products of definite cleavages of primitive muscular fibres. In studying them carefully with a power of 800 to 1000, we have been able to detect no remains of their early formative conditions. Furthermore, we know that the muscular fibre is the primitive embryological element of this tissue. It therefore appears to us probable that this peculiarity of the thoracic muscles of insects is due simply to readiness for cleavage, and which may be subservient to their rapid and delicate action.

Another point which we have noticed, and which Aubert also has alluded to, is the singular spiral aspect which these fibrillæ sometimes assume from an apparently irregular movement in their contraction. This is particularly worthy of note now, since, recently, Martin Barry (*Müller's* Arch. 1850, p. 529) has advanced the doctrine of the spiral structure of muscular fibrillæ. We have not critically examined the ground on which Barry has based

* Ueber die eigenthümliche Structur der Thoraxmuskeln der Insekten, in *Siebold & Kölliker's* Zeitsch. für Zool. iv, 1853, p. 388, Taf. xv.

his views, but from our knowledge of this tissue, the phases of its formation from the earliest to the perfect state, and the various appearances it presents in different parts of the animal kingdom, we are led to venture the conjecture that its alleged spiral structure, may be due to irregularities and anomalies of contraction.

IV. *On the presence of a layer of transversely striated muscular fibres in the Choroidea of Birds.*

The presence of this form of tissue in this locality has recently been announced by Wittich,* and the subject is of so much interest from some physiological bearings, that it deserves a special mention. It may not, perhaps, be remembered that two or three years since, Rainey† announced that he had discovered striated muscular fibres in the posterior portion of the choroidea of the eyes of mammals. This anatomical contribution of great importance in the physiology of the eye, if true, was verified to a certain extent by Henle; but Wittich has been unable to observe any such structure in the Ruminantia, Rodentia, and Carnivora, and in man; he has, however, contrary to the statements of Rainey, detected this tissue in the whole posterior half of the choroidea of birds. As to the manipulation and preparation for the observation of this tissue, I will quote Wittich's own words:

"For the most intimate research, I can best recommend the eye of the thrush. This having lain a short time in diluted alcohol, not only the retina, but also its subjacent membrana pigmenti can be entirely removed. This being done, the choroidea can be removed from the sclerotica and spread out on a plate of glass; here its external tunic containing the vasa vorticosa is to be separated from it. Between this external tunic and the membrana pigmenti there is a layer which usually can be completely isolated; this layer is pretty clear, transparent, and contains throughout only a few of the star-like pigment cells which belong to the choroidea; in it may be easily seen an open net-work, composed of muscular bundles, arranged in an interlacing, and often a radiating manner. The bundles are slightly yellowish, but their contours are sharp from the action of the spirit, and the transverse striæ are boldly prominent. The separate bundles become pretty attenuated, and in this way disappear in the connecting tissue which forms the basis of the whole layer. They disappear towards the ciliary border, the meshes becoming more open, but they are most numerous towards the pecten of the choroidea.

* *Siebold & Kölliker's* Zeitsch. f. wissenschaftl. Zool. IV. p. 456, Apr. 1853.

† "Description of a muscle of the striated variety, situated at the posterior part of the choroid coat of the eye in Mammals, with an explanation of its mode of action in adapting the eye to distinct vision at different distances." By *Geo. Rainey*, Proceed. Roy. Soc. 1851, Jan., p. 23.

Rainey regards this choroid muscle as the analogue of the ciliary muscle of birds, a view which, *Wittich* shows to be unfounded.

The thickness of the primitive bundles corresponds exactly to that of Crampton's muscle. 'This muscular layer is less easily observed with the eyes of doves, hens, turkeys, geese, ducks and crows, owing to the greater number of pigment cells in the choroidea, and to the greater disposition of the primitive muscular bundles to split up into the fibrillæ, which have a varicose aspect, and are almost exclusively seen in prepared specimens."

As to the function of this muscular layer, Wittich remarks: "Its action would contract the choroidea, thereby diminishing its concavity, and at the same time move the vitreous humor and the lens forward; the pressure on the vasa vorticosa being lessened these would be filled with blood, while the processus ciliares would be diminished from the increased pressure upon them of the aqueous humor. 'The whole mode of life of the birds, the sudden movements which they make, from which it is necessary that their eyes shall act over the most variable distances, all require the existence of a very complex and delicate muscular apparatus." He then alludes to the well-known relations of *Crampton's* muscle and of the pecten; in the same category with which belongs the muscular tissue in question.

Wittich's concluding remarks may well be quoted: "I will here mention a circumstance which seems to me well worthy of especial attention in comparative anatomy, but which unfortunately I have been unable to follow out thoroughly. It is, that with some birds there is a considerable thickening of the outer vascular layer of the sclerotica, which, in the eyes of geese and ducks, is composed of a peculiar arrangement of the blood-vessels like the choroidal glands in fishes. In fishes, as well also as in the amphibia I have examined, I have seen no muscular layer of the choroidea; but in the eye of *Cyprinus erythrophthalmus* and *carpio*, there are many delicate, ribband-like, slightly attenuated forms, which, in their general aspect, and their behavior in acetic acid, closely resemble the cells of smooth muscular fibre. Moreover, their relative situation to the parts is the same as the muscular bundles of the choroidea of birds just described."

These observations of *Wittich* are of more importance than would at first appear; for, aside from the presence of this muscular layer which he has discovered, the existence of *Crampton's* muscle has been disputed by some anatomists (see *Huck*, Die Bewegung der Krystallense, Leipzig, 1841); but now. from the investigations of our author, which so completely confirm those of Treviranus, Crampton, and Krohn, the case admits of little doubt.

The striated, and therefore voluntary character of this whole system of muscular apparatus is especially worthy of note in connection with the eminently adaptive power it gives to the eyes of these animals.

V. *On the seat of the Sugar formation in the Animal Body.**

As is well known, *Bernard* (Compt. Rend. xxxi, p. 572, 573,) has shown the existence of sugar in the liver, not only of all vertebrates, but also in that of the Gasteropoda, Acephala, and Decapods. *Frerichs* (Article, *Verdauung* in *R. Wagner's* Handwörterb, d. Physiol. p. 831,) has confirmed these observations for the liver of man, and many animals; *Van den Broek* (Nederlandsch Lancet, p. 108–110) for that of dogs and rabbits; *Baumert* (*Erdmann's* Journal, liv, p. 359) for that of the fox, the dog, the cat, and the sheep; and *Kunde* and *Lehmann* (*Kunde*, De Hepatis ranarum exstirpatione, Diss. Berolini, 1850, p. 11) for that of frogs.

I selected twelve frogs for my investigations, (says Dr. Moleschott,) and notwithstanding the smallness of their livers, so much sugar appeared that it was easily shown by Trommei's test. Bernard and Lehmann regard this sugar of the liver as grape-sugar.

The question arises, is this sugar of the liver derived from the blood, or is it formed by the liver proper? Bernard advocates the latter view, since he has thus obtained the sugar wholly independent of the food, with the Carnivora and Herbivora, with animals famished during hibernation, and with the fœtus in utero. Frerichs, Van den Broek, and Baumert, have repeated these observations and confirmed them.

Still more important is the result obtained by Bernard (loc. cit.) and Lehmann (*Erdmann's* Journal liii, p. 214, 215) that the partal blood of the dog and horse contain little or no sugar, while the blood of the hepatic vein contains, like no other vein in the body, this substance in considerable quantity.

To these data I would add a fact of some import. If the sugar is not found in the liver, but is only strained off, as it were, by this last from the blood, then the blood of those animals whose liver had been removed would be found surcharged with sugar, exactly as the blood is filled with urea in animals whose kidneys have been removed. But with frogs, some of which had been without the liver for fourteen days, others for three weeks, I found no sugar in the blood, flesh, gastric juice, urine, nor finally in the water in which twenty-six of these animals thus mutilated had passed two days.

From all these facts it appears to me indubitable that the sugar contained in the liver is formed by the liver itself.

* Translated from *Müller's* Arch. 1853, March, p. 86.
(Ueber die Bildungstätte des Zuckers im Thierkörper. By *Dr. Jac. Moleschott.*)

A list of the Works and Articles upon Anatomy and Physiology published since 1853, *which have come under our notice.*

As some of the Continental works of the latter part of 1852, of great importance, did not reach us until this year, we have included them in our list.

This list commencing thus with 1853, will be continued in each No. of the Journal and will be made as complete as our means will allow.*

1. SPECIAL WORKS.

Beiträge zur mikroskopischen Anatomie und Entwickelungsgeschichte der Rochen und Haie; von Dr. Franz Leydig. Leipzig, 1852.

Anatomisch-histologische Untersuchungen über Fische und Reptilien; by the same. Berlin, 1853.

[These works of *Leydig* are of the first order, and their microscopic details are illustrated with many excellent figures. We shall have occasion to refer to them particularly hereafter.]

Entwickelungsgeschichte des Meerschweinchens; von Th. Ludw. Wilh. Bischoff. Giessen, 1852.

A Text Book of Physiology; by Dr. G. Valentin. Translated and edited from the 3d German edit. by William Brinton, M.D. London, 1853.

The Dissector's Manual of Practical and Surgical Anatomy; by Grannus Wilson, F.R.S. London, 1853.

2. PERIODICAL LITERATURE.

Siebold & Kölliker's ZEITSCHRIFT FÜR WISSENSCHAFTLICHE ZOOLOGIE. Band iv, Heft. 3, 4. April, 1853.

[This Journal which, in the department of Physiology and minute Anatomy, has no equal anywhere, we shall frequently draw from in making our selections. Where all is so interesting, we cannot do otherwise than present the contents of this No. in tabular form.]

Cohn, Beiträge zur Entwickelungsgeschichte der Infusoria.
Bruch, Beiträge zur Anatomie und Physiologie der Dünndarmschleimhaut.
Gegenbaur, Kölliker & H. Müller, Bericht über einige im Herbste 1852 in Messina augestellte vergleichendanatomische Untersuchungen:
Kölliker, Entwickelung von *Tubularia* und *Campanularia*.
—— über Siphonophoren.
—— über Rippenquallen.
—— über Scheibenquallen.
—— neuer Schmarotzer, Lophoura.
—— Bau von *Leptocephalus* und *Helmichthys*.
—— Sigenthümliche Hautorgane und Wirbel von *Chauliodus*.
Gegenbaur, Entwickelung der Echinodermen.
—— Bau der Heteropoden und Pteropoden.
H. Müller, Ueber Salpen.
—— Bau der Phyllirrhoe.
—— Bau der Cephalopoden.
—— Ueber die Hectocotylen.
Kölliker & Gegenbaur, Entwickelung von Pneumodermon.
Kölliker & H. Müller, Chromatophoren bei *Cymbulia*.

* We are under grateful obligations to *Prof. Agassiz* who has afforded us invaluable facilities in freely opening to us his rich and extensive library. Aside from constant purchases, this gentleman's eminent position causes his library to be well stocked with all new works in natural science.

Supplement.

Kölliker, Lüftlocher der Schale der Velelliden. Guanin bei *Porpita.*
Gegenbaur, Larve von Pneumodermon, Circulationsverhältnisse der Ptero- und Heteropoden, Entwickelung der Schiebenquallen u. von *Velella.*
Bruch, Ueber die Entwickelung der Clavicula und die Farbe des Blutes.
Leydig, Zoologische Notizen.
Aubert, Ueber die eigenthümliche Structur der Thoraxmuskeln der Insecten.
Siebold, Ueber die Verwandlung des *Cysticercus pisiformis* in *Taenia serrata.*
—— Ueber die Verwandlung der Echinococcus-Brut in Taenien.
—— Ueber *Leukochloridium paradoxum.*
Czermak, Ueber den Stiel der Vorticellen.

Smaller Communications and Correspondence.

Nordmann, Ueber *Tetrarhynchus.*
Bilharz, Fernere Mittheilungen über *Distomum haematobium.*
Wittich, Histologische Mittheilungen.

Müller's Archiv für Anatomie, Physiologie und Wissenschaftliche Medicin, Heft. i, March.

J. Müller, Ueber die Semitae Spatangoiden.
Leydig, Einige histologische Beobachtungen über den Schlammpätzger (*Cobitis fossilis*).
Meyer, Das aufrecte Stehen.
Schlemm, Ueber die Verstärkungsbänder am Schultergelenk.
Fick, Beitrag zur Mechanik des Gehens.
—— Ueber die Architectur des Schädels der Cerebrospinal organismen.
Moleschott, Versuche zur Bestimmung der Rolle, welche Leber und Milz bei der Ruckbildung spielen.
—— Ueber die Entwicklung der Blutkörperchen.
—— Ueber die Bildungsstätte des Zuckers im Thierkörper.
Krohn, Ueber einige niedere Thiere.
Kohlrausch, Beiträge zur Kenntniss der Schilddrüse.

Annales des Sciences Naturelles, xix, 1853, No. 1.

Pontallei, Observations sur Lombrie terrestre.
Lacaze-Duthiers, Recherches sur l'armure génitale femelle des Insectes hémiptères.

Quarterly Journal of Microscopical Science.—[No. 1, of this valuable Journal, was published in October, 1852, but we record its articles that our list here may be complete.]

Huxley, Lacinularia Socialis. A contribution to the Anatomy and Physiology of Rotifera. p. 1 (of Transact. Microsc. Soc. Lond.)
Mummery. On the development of Tubularia indivisa. p. 28, (ibid.)
Williamson, On the Anatomy of Melicerta ringens. p. 1, and 65.
Lister, Observations on the contractile tissue of the Iris. p. 8.
Huxley. Observations on the existence of cellulose in the tunic of Ascidiens. p. 22.
Kölliker, Description of Actinophrys sol. (Transl.) p. 25 and 34.
Busk, Some Observations on the Structure and development of Volvox Globator, and its relations to other unicellular plants. p. 31. Transact. Microsc. Soc.
Williamson, Further Elucidations of the Structure of Volvox Globator. p. 45. Ibid.
Gosse, On the Structure, functions, habits and development of Melicerta ringens. p. 71.
Huxley. On the Development of the Teeth, and on the Nature and Import of Nasmyth's "Persistent Capsule." p. 149.
Gray, On the Teeth on the Tongues of Mollusca. p. 170.

[This Journal, of which we have seen the first three Nos., contains also translations of various interesting articles from the German and French Journals.]

The Annals of Natural History, vol. xi, January to July, 1853.

Hancock, On the Animal of *Chamostrea albida:* p. 106. On the animal of *Myochama anomioides.* p. 287.

Colbold, Observations on the Anatomy of Actinia. p. 121.
Owen, On the Anatomy of the Wart Hog. (Proceed. Zool. Soc.) p. 246.
Lowe, On the Reproduction of the Frog and Toad without the intermediate stage of Tadpole. p. 341.
Huxley, On the identity of Structure of Plants and Animals.
Crisp, On some points relating to the structure and mechanism of the Wolf-fish (*Anarrhichas Lupus*). p. 463.
Turner, Note on the suborbital gland of the Nylghan. (Proceed. Zool. Soc.) p. 467.
Tomes, On the Structure of the teeth of the American and Indian Tapirs. (Ibid.) p. 472.
Jenyns, On the reproduction of Frogs and Toads without the intermediate stage of Tadpole. p. 482.
McDonald, Observations on the Antennæ in a small species of Crustacean. p. 488.

PHILOSOPHICAL TRANSACTIONS, 1852. [Received in 1853.]

Wharton Jones, Discovery that the Veins of the Bat's Wing (which are furnished with valves) are endowed with rythmical contractility, and that the onward flow of the blood is accelerated by each contraction. p. 131.
Hancock and *Embleton*, On the Anatomy of Doris. p. 207.
Gray, On the Development of the ductless glands of the Chick. p. 295.
Nelson, The reproduction of the Ascaris mystax. p. 563.
Williams, On the Blood proper and Chylaqueous fluid of Invertebrate Animals. p. 595.

THE TRANSACTIONS OF THE LINNÆAN SOCIETY, vol. xxi, p. 1.

Blackwall, Experiments and Observations on the poison of Animals of the order Araneidea.
Newport, The Anatomy and Development of certain Chalcididæ and Ichneumonidæ. compared with their Special Economy and Instincts; with descriptions of a new genus and species of Bee-parasites.
—— Further observations on the genus *Anthophorabia*.

MEMOIRS OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES. New Series, vol. v, Part 1, 1853.

Burnett, Researches on the Origin, Mode of Development, and Nature of the Spermatic particles among the four classes of the Animal Kingdom.

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE, vol. v, 1853.

Leidy, A Fauna and Flora within living Animals.
Wyman, Anatomy of the Nervous System of Rana pipiens.

The Proceedings of the Academy of Nat. Sci. Philadelphia, and of the Boston Soc. Nat. Hist., which contain constantly valuable contributions in Anatomy and Physiology, are given in full in another part of each No. of this Journal.

ART. XXIX.—*Correspondence of M. J. Nicklès, dated June* 30, 1853.

Chemical Researches on Dyeing.—In the ninth memoir of M. Chevreul on dyeing, communicated recently to the Academy of Sciences, this chemist takes up especially the subject of *the action* which solid bodies may exert, while preserving their condition, on a liquid holding in solution a solid body or a liquid—an action which he designates *capillary affinity*. This kind of phenomenon which has engaged the attention of this learned chemist for nearly half a century, has been observed by him in connection with the fixation of coloring substances which combine chemically with tissues.

After showing that several of the ingredients of mortars, such as gravel, the coarse sand of the Seine, burnt brick, etc., communicate to

the lime water a notable quantity of base, whilst, the limestone when put in a proper flask, loses equally a small proportion, M. Chevreul experiments on the subject under three points of view: to wit—

1. When the solution undergoes no change.

2. When it yields to the solid more water than of dissolved substances.

3. When it yields more of dissolved substances than water.

In the first case, are found, nitrate of baryta and chlorhydric acid, with wool; bichlorid of mercury with cotton. In the second, chlorid of sodium with wool, silk and cotton; alum, sulphuric acid, and nitrate of lead with cotton only: finally, chlorohydric acid, nitrate of baryta, with silk and cotton. In the third case, there are limewater and barytic water, which yield to the wool, silk or cotton, more of dissolved ingredients than water; and the same is true of sulphuric acid, bichlorid of mercury, alum and nitrate of lead, as regards both wool and silk.

But although cotton absorbs a solution of bichlorid of mercury in the proportions of the solution, and while it absorbs more of water than of alum, it is not less true, that it should have some affinity for the dissolved body; and M. Chevreul has observed, that after the most thorough washings, and when the water from the cotton dipped in the bichlorid of mercury, gives no longer a reaction with the salts of silver, the cotton itself is still colored black by sulphuretted hydrogen. In the same way, the cotton soaked in alum retains alum enough to become colored in the cold by infusion of cochineal, woad, logwood, and madder. Cotton dipped in nitrate of lead or nitrate of baryta, acts in the same manner.

All these results have some relation to the temperature at which the operation has taken place, and the length of time of the immersion of the tissues. This action of solids in destroying solutions, shows why it is often so difficult to wash certain precipitates, and how filters may act chemically on the liquids that pass through them.

This series of facts, to which belong also the decolorating and disfecting effect of carbon, and its action on solutions of the proximate principles, was published by M. Chevreul in 1809, and M. Tilloy of Dijon has founded on this action a process for extracting scillitine, and Lebourdais another for extracting the organic bases.

In the military bleaching establishment of St. Denis, where are bleached 6000 linen shirts per day, the fact has been fully recognized that the linen weakens promptly the alkaline lye, by taking up the alkali; and this is therefore, an example of the same kind with those treated of by M. Chevreul.

All these facts, which M. Chevreul groups under *capillary affinity*, have some applications even to physiology. For after observing that an organic tissue attacks a solution by appropriating one of its approximate principles present in larger proportion than another, we readily conceive that analogous effects may take place in the organic economy, without the necessity of recurring to vital action in order to explain the first cause of the fact. Water may permeate a membrane, a cellule, or a vessel, to the exclusion of a substance which it holds in solution, and this without any glandular apparatus. We comprehend how solutions which act on the organ of taste, or in the interior even of some organ, may produce some effects at a certain degree of concentration,

which disappear, or which are not produced when the proportion of water is more considerable.

The facts may explain the observation by Th. de Saussure, that the roots of plants placed in certain saline solutions absorb proportionally more of water than of the salts dissolved. M. Chevreul, moreover, shows this fact by a simple experiment, by putting into one of the branches of a curved tube a solution of common salt, and in the other, dry tissue, tendons, e. g., the tube being hermetically sealed; after some time a crystallization of the salt is seen above the level of the liquid.

Pisiculture.—M. de Quatrefages has communicated to the Academy some important researches bearing on different points connected with the artificial fecundation of the eggs of fishes. Assisted by M. Millet, of whom we have spoken in our last communication (p. 104 of this volume,) he has first shown that the temperature of the water for fecundation is a point deserving especial attention. This temperature varies for each species, and it is well to ascertain it for each separately. In general, for the winter fish, as trout, it is between 6° and 8° C.; for the early spring fishes, as pike, 8° to 10°.; for the later spring, as perch, 14° to 16° C.; and finally for the fishes of summer, as the barbel, 20° to 25° C.

The necessity of a specific temperature is connected also with the vitality of the spermatozoids of different species, which is of short duration, it not exceeding 8 minutes in the pike, whilst in man it lasts 8 hours. The maximum of vitality for the spermatozoids of the pike has been obtained at +2° C.; a higher temperature destroys them rapidly. The spawn of the pike is kept perfectly well in ice water, and the spermatozoids perish only with a cold below 10° or 12°.

This influence of temperature on the vitality of the spermatozoids of fishes, and therefore on the fecundation of eggs, presents a reason for the instinct which urges certain fishes to ascend streams, and at times to penetrate into rivulets where they have hardly water enough for their movements.

M. de Quatrefages deduces some rules which are important to the art of pisciculture, bearing especially upon the preservation of the spawn.

1. The water should not be supplied with the spawn in advance; it is well to leave the spawn in place even till the moment of employing it, and the fecundation should follow soon, upon the death of the male fish.

2. Since the fecundation should take place within a day or twelve hours after the death of the animal, the spawn should be then taken and kept separate.

3. To preserve the spawn, it should not be placed in the water, or in the open air, but better in a moist linen cloth, which is kept at a temperate equal to, or a little below that, which for each species gives the maximum duration to the movements of the spermatozoids.

4. If there are several fecundations to operate successively, it is necessary to detach for each, the quantity of spawn required, and leave the rest in some convenient place.

Over-heated Steam applied to the Carbonizing of Wood.—For several years past, over-heated steam has been used in numerous industrial operations, and we may say generally that it may be employed in all

processes in which a temperature between 100° and 500° C. is required. Among these processes, are the extraction of wood-spirit, the continuous baking of bread, the preparation of sea-biscuit, the drying of wood, the preservation of meats, the extraction of volatile substances insoluble in water, the purification of fatty acids, by MM. Leplay and Dubrunfaut, the extraction of the mercury from the residues of zinc amalgam, by M. Violette, and finally the carbonizing of wood by the same chemist.

M. Violette is a member of the Commission on Powder and Saltpeter and in this situation, he has turned his attention to the ingredients of powder, the manufacture of which still admits of much improvement. The charcoal employed in this manufacture is of a quality intermediate between wood and ordinary charcoal; it is called red charcoal (*charbon roux*,) and is produced at 300° C.; at a higher temperature it becomes black charcoal, and at a lower, the carbonization is incomplete.

By the old process of heating in closed cylinders, 10,000 kilogrammes of wood furnished 2000 kil. of black charcoal, and 1300 of red. The new process with steam yields a better article in larger quantity, for 10,000 kil. of wood, give 4000. The wood immersed in the vapor is readily carbonized, and as it is easy to regulate the temperature of the vapor, charcoal may be obtained of a constant and uniform character. It is some years since that over-heated steam was first adopted in this process, by M. Violette, and now the red charcoal, before employed only for the finest powder, is in general use for the cheaper kinds, so simple and certain is its preparation by means of steam.

M. Violette communicates now to the Academy some new results. He shows that the change to charcoal takes place differently with different woods, and that the products of the same temperature differ in elementary constitution. Exposed to moist air, the charcoals absorb more water, the lower the temperature to which they were exposed, and the inverse is true of their power of conducting heat or electricity. Charcoal made at 1500° C., conducts much better than the charcoal of gas retorts, and serves perfectly for electric illumination. The density increases in the same proportion. When lighted, charcoals remain ignited for a time, which decreases as the temperature of carbonization increases. The charcoal made at 260° C. burns more easily and longer; that made between 1000° and 1500° C. will not ignite or burn.

The most inflammable of all charcoals is that of an Agaricus. It takes fire spontaneously at 300° C. Other charcoals, prepared at the temperature 300° C., take fire in air spontaneously between 360° and 380°, according to the wood that has afforded them, the charcoals of the lighter woods burning the most readily.

When charcoals are mixed with sulphur, they inflame at a temperature much below that required when alone; the mixture of the two prepared between 150° and 400° C., is wholly consumed at 250° C. On the contrary, when the charcoal employed has been prepared at 1000° or 1500° C., only the sulphur burns.

To decompose saltpeter, the charcoals require a higher temperature; a heat of 400° C. is needed for charcoals prepared between 150° and 432°, and a red heat for those made between 1000° and 1500°.

Sulphur decomposes saltpeter at a higher temperature than charcoal requires, viz., at 432°. The sulphur alone inflames in common air at 250° C., and not at 150° as stated in treatises on chemistry.

The deflagration of powder takes place at 250°, but its combustibility varies with the charge, and the size of the grain. The powder in grains burns between 270° and 320°, while powder pulverized, burns between 265° and 270°.

In view of the facts, M. Violette concludes that it is necessary to revise the charges employed, taking into consideration the actual composition of the charcoal. Trials made with this in view upon hunting powder, with charges calculated according to the actual composition of the charcoal, have given a range much beyond the standard rate obtained with the ordinary powder.

Experiments on the Anæsthetic properties of the smoke of the Lycoperdon.—A naturalist of Paris, M. Frederic Gerard, has tried upon himself the effects of the smoke of the *Lycoperdon proteus*, (a species of puff-ball,) observed to be anæsthetic by Mr. Richardson. 12 grammes of this substance were placed on some tinder which kept up the combustion, and he placed his head in it for 15 minutes. It produced a strong irritation of the pharynx, and then of the eyes; after removing the apparatus, he experienced a series of narcotic effects, which inconvenienced him for several hours, and the next day, they had not entirely passed away.

M. Gerard has not succeeded in confirming the assertion of the "Mainzer Volkszeitung," that animals subjected to this smoke, are thrown into a state of prostration resembling death. He has found also that the properties of the *Lycoperdon bovista* and *L. excipulæformis*, are the same as those of the L. proteus.

Chloroformization.—Dr. Jobert de Lamballe, one of the principal surgeons of Paris, who has used chloroform since its anæsthetic properties were made known, has presented a long memoir on the observations which he has made on this subject, and on the precautions requisite in the employment of this stupefying liquid.

We cite some passages from his report.

Use of chloroform should cease, whenever the beatings of the heart lose at once their power and number. The physician should continually keep watch of his patient, and not judge of the action of the chloroform from his irregular movements or loquacity, for the insensibility is often produced even when there is still some agitation of the members or incoherent words; the application should be suspended whenever the pulse falls to 55; at 50 the patient may drop off from paralysis of the heart.

Recourse should not be had to chloroform when there exists any severe organic difficulty. The operation is not advisable when the nervous system has sunk from any violent shock, or when the patient is depressed by languor, abundant suppuration, loss of blood, or an advanced chlorotic state.

When chloroform has exhausted the vital forces, and death is apparent, the surgeon should never abandon the patient without trying for a long time to restore life. It is then well to excite locally the skin with cold water, or with frictions made with alcoholic solutions, alkalies, &c., to reanimate the organs by currents of air directed upon the face and members, giving the patient the position most favorable for reëstablishing the circulation, by placing him horizontally on his back, or

obliquely on one side. In one case of this kind, M. Jobert obtained good effects from the use of electricity.

This surgeon draws a parallel between chloroform and ether. Ether alters the color, and the consistence of the blood; chloroform does neither. Ether hinders often the healing of wounds, chloroform never. Chloroform calms the organs, and ether violently agitates them. Ether over-excites certain senses and certain desires, chloroform never. Ether produces death with difficulty; chloroform may cause life to cease instantaneously, if the patient is not watched, or if the respiring of the chloroform is not properly conducted. We add that quite recently two cases of death from chloroform have happened, under the eyes of physicians.

Composition of matters extracted from fertile soils by water.—In continuation of his long researches on the composition of arable soils, M. Verdeil, chief of the chemical works at the Agronomic Institute of Versailles, and M. Rissler, have recognized in the aqueous extracts of these soils, the constant presence of a substance like sugar; and also a large proportion of mineral substances, little soluble or even insoluble in water. Thus in 100 parts of aqueous extract, they found 49 of organic matter, and 54 of inorganic consisting of sulphate, carbonate and phosphate of lime, oxyd of iron, alumine, magnesia, all insoluble in water (or scarcely soluble); and as the presence of carbonic acid alone is not sufficient to explain the presence of these substances in an aqueous extract, MM. Verdeil and Rissler have sought for the cause of this solubility, and concluded that it is due to the saccharine ingredient; for only a very little water is required along with this sugar to dissolve large quantities of insoluble salts. They have recognized again the fact that nitrogen which enters into the composition of humus is found in the condition of an ammoniacal salt, and not in that of an organic substance; for they have collected the whole under the form of ammonia in boiling the concentrated extract with milk of lime.

Photography.—A discussion has taken place at the Academy, between MM. Arago, Biot and Chevreul, as to the respective rights of Mr. Talbot of London, and M. Niepce de St. Victor, as to the invention of photographic engraving on plates of steel. The processes of these chemists are different. M. Talbot uses for the substance impressible to light a mixture of gelatine and bichromate of potash, which is modified and browned on the immediate contact of light, and only where the light acts, whilst the part covered by the object to be copied remains untouched, and may always be removed by water.

M. Niepce has aimed to perfect the process which his uncle the inventor of heliography described in the year 1827. The sensitive substance is a solution of bitumen in essence of lavender, applied in a layer; this varnish changes its properties while under the action of light. The parts exposed to the sun become insoluble in a mixture of essence of lavender and oil of petroleum, so that they may be easily separated from the soluble part not impressed, which represents the image to be reproduced.

The liquid employed by Mr. Talbot for biting in on steel after his design, is bichlorid of platinum, and that of M. Niepce, a mixture made

of 1 part of nitric acid, 8 parts of distilled water and 2 of alcohol. We mention only these general facts, the details belonging more especially to the domain of technology.

Theory of the Pile and the Aurora Borealis.—M. de la Rive, the celebrated physicist of Geneva, has presented to the Academy the first volume of a treatise on Theoretical and Applied Electricity, which he has published in London, and of which he is now preparing an edition in French. In explaining the plan of his work, M. de la Rive dwelt more especially on the theory of the pile. He has always been a defender of the chemical theory ; but while acknowledging the influence of chemical action, he now recognizes that we cannot always admit that chemical action precedes the production of electricity, and he is led to consider the two phenomena as commonly simultaneous, and due to a more general cause, viz., molecular polarization, which is established at the moment of contact of two bodies susceptible of acting chemically on one another. M. de la Rive also expresses his opinion on the cause of the aurora, which he explains not by a radiation of the polar magnetism, but by a purely electrical action. After examining nearly all recent observations, he believes that he may attribute this phenomenon to the electricity with which the currents of air are charged, that rise from the equatorial regions, and travel in the upper atmosphere towards the poles, where they combine with the negative electricity of the earth, forming under the influence of the magnetic pole, true luminous arches.

Miscellaneous.—Among the various facts communicated to the Academy since my last communication, we mention the following.

The *transformation* of tartaric acid into racemic, by M. Pasteur.

A work of considerable extent *on the variations in chronometers*, by M. Lieussou, Hydrographic Engineer. The causes of these variations are now known ; they are temperature, and the gradual thickening of the lubricating oil. M. Lieussou after explaining the causes, gives the methods of remedying the evils.

A *photographic apparatus* by M. Quinet, for producing at one and the same time two images for use in the stereoscope ; it is a modification of the binocular camera obscura of Brewster.

A note of M. Gorgen, *on the coloration of salts of manganese*, tending to show, that the salts are all colored, and that if M. Voelker has obtained colorless salts, it is owing to impurities, they including certain salts, which like those of cobalt, copper, &c., are not themselves colorless, but afford the complimentary color to that of manganese, so as by mixture to generate a white color.

A letter of M. Dujardin, calling attention anew to the method of *using steam in extinguishing fires.* If one of the passengers of the steamboat Ocean Wave, had known of this property of steam, the disaster which took place on the 30th of April, on Lake Ontario, might have been avoided, or at least rendered less serious.

M. Felix Bernard has described a *new photometer*, and M. Gaugain has announced a *new electroscope* with double condensation, which increases much the sensitiveness of the electroscope of Volta.

Manufacture of Sugar.—Sugar extracted from molasses. The manufacture of beet sugar has for some years been largely carried on in France. In ten years, the production has doubled notwithstanding the

successive duties which have been laid, duties of an excessive character, since 100 kilogrammes of white loaf sugar pay 59 francs of duties, and sell at 150 francs. In 1842, the production of beet-sugar throughout France was about 40 millions kilog., and to day it is 80 millions. This progress has been owing to improvements each year in the manufacture.

Among these improvements, the most important is that called the *barytic*, introduced by MM. Leplay and Dubrunfaut, and which enables them to obtain 50 p. c. of the crystallizable sugar contained in the molasses. It is well known, that for a long time this molasses was of little value. Its sugar was supposed to be wholly uncrystallizable, and its only use was for making alcohol by fermentation, for which purpose large distilleries had been constructed. In an establishment of this kind, directed by M. Leplay, 12000 kilogrammes of the beet molasses were consumed per day, in making alcohol of 94 p. c., which was wholly used in the manufacture of fine liquors.

M. Leplay and M. Dubrunfaut, were the first to recognize that the sugar in the molasses was a sugar perfectly crystallizable, and having all the characters of ordinary sugar; and that to crystallize it, it was only necessary to separate the interfering foreign substances, by operating on the juice of the beet which furnishes the molasses. The solution of the problem was one of great importance, since the amount of molasses annually produced in France, was 40 millions kil., containing more than half its weight of sugar.

Their process, as I have studied it for some years at the establishment of La Villette, near Paris, is as follows. It is based on the insoluble compound, which sugar forms with baryta. When a boiling solution of caustic baryta at 30° Baumé, is poured into the ordinary molasses, the substances contained immediately solidify into a porous crystalline mass, insoluble in water, and admitting therefore of thorough washing.

After being thus purified, the saccharate of baryta is white, and has the appearance of a "bouillie épaisse;" it is exposed to a current of carbonic acid, which takes up the baryta and sets the sugar at liberty. This operation is carried on in large vats of wood, 80 to 100 hectoliters in size, into which strong pumps worked by steam, inject carbonic acid obtained by the calcination of carbonate of lime in lime furnaces.

While the reaction of the carbonic acid is going on, it is observed that the "bouillie" of saccharate, before very thick, gradually liquifies, and when complete, the whole is a solution of sugar containing carbonate of baryta in suspension.

To separate the carbonate, the mixture is put into sacs made of cotton fabric, through which the syrup filters clear, while the carbonate is retained. These sacs, after draining thoroughly, are pressed lightly in a screw press, and then subjected to heavy hydraulic pressure, in order to extract the syrup from the carbonate. This syrup thus obtained, marks 18 to 22° Baumé, it is white, of agreeable taste, and holds in solution some traces of the carbonate and bicarbonate of baryta which may be removed by means of a sufficient quantity of plaster, or of sulphate of alumine. Finally, it is clarified by means of dried blood; it is skimmed and filtered, and boiled down like a syrup for the re-

finery, after which it is put into forms for crystallizing. We thus obtain, at once, sugar equal in quality to the finest sugars of commerce.

With regard to the residues of this process—the carbonate of baryta, saline substances contained in the molasses, quicklime proceeding from the calcination of the limestone, etc., I have learned the following facts. The carbonate of baryta may be used an indefinite number of times; it is rendered caustic anew after each operation, by mixing it with charcoal and heating it, and so it serves again. The loss of the baryta, which is unavoidable is re-supplied from sulphuret of baryum which M. Leplay prepares by calcining sulphate of baryta with 45 p. c. of charcoal, in a reverberatory furnace, and which he would prepare more advantageously still if he would apply the process suggested by Gibbs, which consists in reducing the sulphate by the gas of the refinery. The sulphuret of baryum possesses equally the property of precipitating the sugar, only there are two equivalents of sulphur when one of oxygen would suffice. In fact, this last case gives,

Sugar+BaO+HO= Saccharate of BaO+HO,

whilst the sulphuret affords,

Sugar+2SBa+HO= Saccharate of BaO, SH, SBa.

There is hence lost 1 equivalent of sulphuret of baryum. To avoid this loss, 1 equivalent of potash or caustic soda is added to the molasses under trial; and then on pouring in the sulphuret of baryum, all the baryta is precipitated in the state of a saccharate, and the liquid retains the potassium in the state of a sulphydrate.

2 Sugar+2 SBa+KO+HO=2 Saccharate of BaO+SH, SK. The use of caustic potash produces a residue with carbonic acid, like the quicklime, and would be too expensive for the purpose, were it not regenerated with each operation. In fact, the waters after washing are collected in boilers, evaporated, and the product then calcined in a reverberatory furnace with some chalk or lime, and fused. The fused substance is cooled, broken up, lixiviated, rendered caustic by means of lime, and the leyes are concentrated as in the manufacture of soda. The potash is thus obtained for a new precipitation of the saccharate.

In this operation, they obtain not only the potash added in the process, but also the potash and soda which existed primarily in the juice of the beet, and which, by accumulation in the molasses, amounts to about 10 per cent.

In this manner, MM. Leplay and Dubrunfaut have succeeded in isolating, economically, the sugar of beet molasses. But is this process applicable to the extraction of cane sugar? Yes, on one condition; that is, if the manufacture of cane sugar can be so conducted as to give molasses free from uncrystallizable sugar. For MM. Leplay and Dubrunfaut have shown that for 60 to 70 p. c. of sugar in the molasses, there are 30 p. c. of uncrystallizable sugar, which is a result of the method of manufacture, and not preëxistent in the juice of the cane.

There exists, then, great differences between the manufacture of beet-sugar and cane-sugar; in the former, the molasses contains no altered sugar, and in the latter there is a large quantity of altered sugar.

Manufacture of caustic baryta from the carbonate.—We have mentioned above the general process by means of which MM. Leplay and Dubrunfaut reduce the carbonate of baryta. The point is important

and we add some further details; for it has required much time and experiment to accomplish it conveniently on a large scale. The process is now so far perfected, that caustic baryta may be obtained at a very low price.

After reducing the carbonate to powder, it is mixed intimately with 20 to 25 p. c. of pulverized charcoal, then put in a reverberatory furnace made of good refractory brick. At a reddish white heat the reduction commences, and the aspect of the mass shows when it is complete. A single furnace will thus reduce in 24 hours 1200 kilogrammes of carbonate of baryta, consuming 12 hectoliters of charcoal in heating, and 4 hectoliters for the reduction. Three workmen are required. When finished, the baryta is collected in metal cases, ("étouffoirs," large sheet-iron boxes holding about 1 hectoliter,) where it is cooled. The artificial carbonate is usually reduced more easily than the native. However, the native carbonate from England is easily decomposed.

Caoutchouc industry.—Since Mr. Goodyear, of New Haven, Ct., has discovered the method of preserving caoutchouc elastic at all temperatures by vulcanization, this substance has become the basis of a branch of industry of the highest importance. The vulcanization of caoutchouc has been what the electro-magnet was to the electric telegraph the parallelogram to steam-engines, or tubular boilers to rapid locomotion—a discovery, great in its numerous applications, and the services which it has rendered to society.

The several branches of this industry have been undergoing constant improvement since they were first commenced. Among them we have already, in a former paper, alluded to the manufacture of caoutchouc thread.

Two processes are ordinarily used in working caoutchouc. One consists in macerating it in essence of turpentine, or naptha, till it is soft; it is then worked between cylinders till the solution resembles a soft pitch, when it is applied, usually between two pieces of cloth, so as to fit it for all the purposes of clothing, and numerous other objects.

By the other process, the cautchouc is compacted so as to form a single mass, sheet, or block, and mainly by heat and pressure. The methods are well known, and I do not dwell upon them. The processes which I would here mention, are employed by Mr. Gerard, at Grenelle, near Paris. They have the advantage of not altering the caoutchouc, and of admitting of being employed from one day to the next.

In these processes, the paste of caoutchouc acquires certain peculiar properties; it is not pasty, and will keep the form impressed upon it. Alcohol, an anti-solvent of caoutchouc, is the agent which M. Gerard used for this purpose. By causing the alcohol to penetrate the caoutchouc, the adhering molecules are disunited, as completely as when alcohol is poured into a limpid solution of caoutchouc. The solvent which is preferred for use is the sulphuret of carbon, to which is added from 2 to 25 p. c. of alcohol. To 1 part of caoutchouc, from 1 to 30 or 40 parts of the dissolving alcoholized material, according to the quality of the paste desired.

The clear solutions are applied with a brush, and dry promptly; those in a pasty state are used for making thread, tubes, leaves, etc.

The elastic material, driven by a piston through small holes, is thus made into threads; the holes are in a single range, that the threads may not fall upon one another. The threads are received on an endless band of velvet, and thus make a traverse of 4 metres; they pass then to a linen cloth or band, also without end; a sieve, shaken with an eccentric motion, sprinkles some talc over the threads, to prevent their adhesion. This movement on endless bands serves to promote the evaporation of the solvent.

The details of this process cannot be given without numerous figures, and I therefore mention only the principal steps in the manufacture. The size of the threads of caoutchouc may be varied at will. A thickness of 1 millimiter is usually preferred; but often a much finer thread is desired. M. Gerard converts the larger into smaller threads of any size desired, by means of a property which he was the first to recognize in caoutchouc—that of reheating ("recuit"). It is well known that a thread, when drawn out, will return to its former length when the force is removed. But it was not before known, that this thread when drawn out and exposed to a heat of 115° C., would retain the length and size thus given it, and, moreover, it is also ready to be drawn anew. By drawing it thus, and re-heating it, successively, a thread of caoutchouc may be brought to any degree of fineness, limited only by the skill of the workman. A length of 50,000 metres may be obtained from a kilogramme of material.

The thread thus obtained is of ordinary caoutchouc, but it is easy to make the vulcanized thread in the same manner. It is only necessary to incorporate into the pasty caoutchouc some flowers of sulphur, and heat up to 130 or 140° C. M. Gerard vulcanizes also by a process peculiar to himself, which consists in exposing the caoutchouc in an alkaline persulphuret to the action of a temperature of 150° C. This process gives good results, but the product is black.

For weaving, both kinds of thread, the vulcanized and non-vulcanized are used. Deprived of elasticity, the natural thread may be worked like any other textile material, and the elasticity may be afterwards restored, by passing a hot iron over the tissue. The vulcanized caoutchouc cannot be woven without the aid of a peculiar artifice; it must be extended by weights.

M. Gerard manufactures thus at Grenelle on an average 700,000 metres of caoutchouc thread per day. It is the only round thread used in France, the United States, England, or Germany. All other threads are square, and are obtained by cutting; they therefore have not the strength or homogeneity of the round even thread.

Locomotion by compressed air.—I close this communication by some details relative to a recent invention of considerable notoriety. The inventor, M. Julienne believes that it will prove an economical motive power of great value. What I have seen of it, satisfies me that obstacles which have till now opposed the employment of the expansive force of compressed air will disappear through the process of M. Julienne, which consists simply in compressing air by means of an hydraulic press.

By this method, M. Julienne substitutes for the *solid* piston—which a grain of sand may alter, which the slightest irregularity in the

pump would throw out of action, and which becomes heated by friction,—a liquid piston, not less incompressible than the other, filling always exactly the space in which it moves, be it regular or not, and acting by progression on a resistance so exactly calculated, that its proportion, although increasing, is always in relation to the force to be overcome.

The air is thus compressed at 30 atmospheres in iron bottles, which are about 4 millimetres thick. It is perfectly preserved under this pressure, and it was with a bottle of this kind that M. Julienne put in action, in my presence, a small vehicle, carrying two persons, and moving with great rapidity.

SCIENTIFIC INTELLIGENCE.

I. Geology.

1. *Records of the School of Mines, and of Science applied to the Arts*, Vol. 1. London, 1852. 8°.—Contains inaugural and introductory lectures to the courses for the session of 1851–2. We would notice the lecture of Prof. Ed. Forbes upon the Relations of Natural History to Geology and the Arts, as particularly interesting to the Zoologist. L. A.

2. *A Geological Map of the United States and the Britith Provinces of North America, with an explanatory text, geological sections, and 8 plates of the fossils which characterize the formations*; by Jules Marcou. Boston, 1853. 8°.—A comprehensive illustration of the Geology of the N. American Continent. L. A.

3. *Memoirs of the Geological Survey of the United Kingdom. Figures and descriptions illustrative of British organic remains.* Decade vi. London, 1852. 4°.—Contains descriptions of nine new species of fossil fishes from various geological formations, by Sir Philip de Malpas Grey Egerton, among which is the type of a remarkable new genus from the chalk of Sussex. It is highly gratifying to the writer to see that the fossil fishes recently discovered in Great Britain, are likely to be all described in a satisfactory manner by so competent an observer as Sir Philip Egerton, whose collection of fossil fishes, in connection with that of his noble friend, the Earl of Enniskillen, is unrivalled. L. A.

4. *Histoire des progrès de la Géologie de* 1834 *à* 1850, per A. d'Archiac. Paris, 1851. 4 vol.—This work, of which we have recently received the fourth volume, is not merely a history of the recent progress of geology, but a real encyclopedia of all the branches of science related to geology, and ought to be studied carefully by every geologist and palæontologist. L. A.

5. *Zeitschrift der deutschen geologischen Gesellschaft*, 4th vol. Berlin, 1852. 8°.—This and the preceeding volumes contain highly valuable papers upon Geology and Palæontology. L. A.

6. *Jahrbuch der kaiserlich-koniglichen geologischen Reichsanstalt*, Wien, 1852. 4°.—The third volume of a very valuable series of papers upon a variety of subjects relating to Geology, Palæontology, and Mining. L. A.

7. *Geognostiche Wanderungen in Gebiete der nordöstlichen Alpen;* von CARL EHRLICH. Linz, 1852. 8°.—Geological Sketches of Upper Austria, with descriptions and figures of fossils. L. A.

8. *Die Braunkohle in der Mark Brandeburg;* von Dr. E. PLETTNER. Berlin, 1852. 8°, with a map and 4 plates.—An account of the lignites of the mark of Brandeburg, chiefly geological. L. A.

9. *Halurgische Geologie;* von Dr. F. v. ALBERTI. Stuttgardt, Tübingen, 1852. 8°.—A complete treatise of all matters pertaining to the geology of salt, its occurrence, its origin, its associations, &c., &c.

L. A.

10. *Lehrbuch der Geognosie;* von Dr. C. F. NAUMANN. Vol. 2d, part 2d. Leipzig, 1852.—One more number, and this excellent textbook of Geology will be complete. What renders it particularly useful, and superior to most other works of the kind, is the beautiful atlas of characteristic fossils which accompanies it. L. A.

11. *H. G. Bronn's Lethæa Geognostica.* 3d edition published in connection with F. ROEMER. Stuttgardt, 1852. 8°.—Too well known from the former editions to require particular notice. We would only state that the new discoveries in Palæontology have been faithfully incorporated in this new edition. L. A.

12. *Deutschlands Petrefacten*, von C. G. GIEBEL. Leipzig, 1852. 1 vol. 8°.—A complete systematic catalogue of all the fossil organic remains discovered to this day in Germany and the adjacent countries, with their synonyms and the indications of the localities and geological formations in which they occur, and references to the works in which they are described. It is for Germany what *John Morris's Catalogue* is for Great Britain, and *Bronn's Index Palæontologicus* for the whole world. This last work, yet little known in this country, ought to be in the library of every geologist. L. A.

13. *Fauna der Vorwelt, mit Natur Berücksichtigung der lebenden Thiere.* Von Dr. C. G. GIEBEL. Vol. 3d. Leipzig, 1852. 8°.—This volume contains a very full description of the fossil Cephalopods known to this day. It is an indispensible work for every palæontologist. The first volume of the work is devoted to the Vertebrata. The second has not yet appeared. L. A.

14. *Zoologie et Palèontologie Françaises (Animaux vertébrés) ou nouvelles recherches sur les animaux vivans et fossiles de la France.* Par P. GERVAIS. Paris, 1852. folio. No. 15, 16, 17 and 18.—The concluding numbers of an extensive work upon the fossil remains of vertebrated animals in France. L. A.

15. *Palæontographica, Beiträge zur Naturgeschichte der Vorwelt,* von W. DUNKER and HERM. VON MEYER. Vol. 2d, No. 6.—Contains the description of some remarkable fossil plants from the lithographic limestone of Solenhofen by Professor Fr. Unger. The author shows that the fossil remains referred by Count Sternberg to the family of Algæ, under the name of Caulerpites, are genuine Coniferæ, constituting a distinct genus, which he calls *Arthrotaxites.* The same No. contains interesting contributions to the tertiary flora of Silesia, by Prof. *H. R. Göppert.* Among them, we notice particularly a maple, the fruit of which measures not less than six, and sometimes over eight inches in length. L. A.

16. *Description of the remains of extinct Mammalia and Chelonia from Nebraska Territory, collected during the Geological Survey under the direction of Dr. D. D. Owen*; by Jos. LEIDY, M.D. From D. D. OWEN'S Report of a Geological Survey of Western Iowa, and Minnesota, &c. Philadelphia, 1852. 4°.—This memoir affords another evidence of Dr. Leidy's indefatigable industry and devotion to the study of Natural History in all its departments. His descriptions are very full and precise; we only regret that there is nowhere yet in the country a collection of skeletons sufficiently extensive to enable our palæontologists to compare minutely the fossil remains which they describe with the bones of living animals. What interesting results might not have been derived from a careful comparison of so many fossil turtles, so well preserved as those here described and figured, with the numerous representatives of that family inhabiting even the United States. The fossil Fauna of Nebraska is one of the most important yet discovered in North America, and may furnish many more interesting extinct forms.

The mammalia described by Dr. Leidy belong to his new genera Oreodon, Archæotherium, and Eucrotaphus, and to the genera Palæotherium, Rhinoceros, and Machairodus, he and Dr. Owen have added new species, all of which are beautifully illustrated. The reptiles, four in number, belong all to the genus Testudo proper. Besides the species described in full, there is at the close of this paper a list of five other species mentioned elsewhere before. L. A.

17. *Memoir of the extinct species of American Ox*; by Jos. LEIDY, M.D. From the Smithsonian Contributions to Knowledge. Vol. v.—This is a very valuable contribution to the natural history of the fossil species of Ox found in North America. The author refers them to two genera: 1st, *Bison*, the type of which is our Buffalo, and, 2d, a new extinct genus, which he calls *Bootherium*, which contains two distinct species. The validity of these distinctions seems satisfactorily established; it is also very interesting to learn that remains of the common buffalo are found among the fossils of Big-bone Lick, in Kentucky. But we cannot help repeating our regrets, that such important investigations should be carried on without the possibility of direct comparisons with the skeleton of our living species. It is a strange fact, that there is no skeleton of the Buffalo in any American museum, except that of the Natural History Society in Boston. It remains, therefore, for future investigations to ascertain what is the degree of affinity of the fossil American Bulls with the living species of this continent. L. A.

18. *Die Versteinerüngen der Grauwacken formation in Sachsen ünd den angrenzenden Länder-abtheilungen*, von H. B. GEINITZ. No. 1, Graptolites. Leipzig, 1852. 4°.—No family of fossils has puzzled the palæontologists in a higher degree than the Graptolites, especially when it has been attempted to assign them a place among organized beings. The nearest approach to a natural classification has been proposed by Barrande and Geinitz, who compare them to those Haleyonoid and Hydroid Polypi, in which the individual animals are arranged in regular rows, such as Virgularia and Sertularia. I believe, however, that their true position is neither among Polyps, nor among Acalephæ, to which class the Hydroid polyps must now be referred, but among Molluscs, in the class of Acephala, in the order of Bryozoa, of which many are found

in a fossil state in the palæozoic rocks. My reason for assigning such a position to the Graptolites, is the discovery I have made in Florida upon the coral banks of Key-West, of a new genus of Bryozoa, in which the arrangement of the cells resembles that of the Graptolites still more than either Virgularia and Sertularia, and the delicate stem of which, if fossilized, would probably have left an impression very similar to that of most Graptolites. I have not yet had an opportunity of publishing my investigations upon this singular creature; but I have no doubt left in my mind that it is a living representative of the fossil Graptolites, for which I propose the name of Cladobryus hyalinus, as it differs from most of the ordinary Bryozoa, by the regular branching of its stem, and resembles, in that respect strikingly, the new genus Cladograpsus of Geinitz. I have collected a sufficient supply of this remarkable animal, in alcohol, to provide all the palæontologists with it. To trace the true affinities of the Graptolites, the genera Crisia, and Eucratea, ought to be compared. Upon this interesting subject, compare, also, J. Hall's Palæontology of New York, vol. i and ii.

L. A.

19. *Beitrag zur fossilen Flora von Wildshuth in Oberoestreich*, von Dr. C. von ETTINGHAUSEN, with 4 plates. From the Proceedings of the Imperial Academy of Sciences at Vienna, vol. ix, 1852.—Descriptions and Figures of many fossil plants from the lignites of Wildshuth, in Upper Austria. L. A.

20. *Neu aüfgefundene Saurier-Ueberreste aus den lithographischen Schiefern des obern Jurakalkes*, von Dr. ANDREAS WAGNER. München, 1852. 4°. From the Transactions of the Royal Academy of Sciences of Bavaria, vol. iii.—Contains full descriptions and accurate figures of two new genera of fossil Saurians, Pliocormus, and Homœosaurus, and new contributions to the knowledge of several Pterodactyls, with new species of Pliosaurus, Ichthyosauras, and Stenosaurus.

L. A.

21. *Description des Mollusques fossiles qui se trouvent dans les grès verts des environs de Genève*, par F. J. PICTET. Genève, 1852. 4°. 3d number.—The third number of an elaborate monograph of the cretaceous fossils of the vicinity of Geneva, in Switzerland, with many beautiful plates. A work indispensible for the identification of our greensand fossils. L. A.

22. *Die Kreidebildungen von Texas und ihre organischen Einschlüsse*, von Dr. FERD. ROEMER. 4°. Bonn, 1852.—A very handsome volume, giving an account of a geological survey of Texas, and the description of the fossil remains found in the cretaceous and tertiary formations of that state, with eleven magnificent plates. L. A.

23. *Système silurien du centre de la Russie par Joachim Barrande.* 4°. 1852. 1 vol. letter-press, 935 pages: 1 vol. plates, 52 in number.—This work, advertised for many years, has at last made its appearance in a shape that exceeds the most sanguine expectations. It is natural to have to wait for such productions. The first volume now before us contains only a monograph of the Trilobites; but they are illustrated as fully and minutely as if the dissections had been made from specimens just caught upon some mud-flat left dry by the ebb tide, and the changes some of them undergo with age are treated as extensively

as if they had been hatched in confinement, and brought up in a nursery. Zoologists may well be called upon to imitate the example modern palæontologists give them; living animals ought, indeed, to be so minutely described as to furnish ready means of comparison in the identification of fossils, whilst of late the most important contributions to Natural History have been made by palæontologists. Science has another master worker in its service, for we may almost consider this book as the first work of Mr. Barrande. L. A.

[NOTE.—In § 13, p. 280, for *Natur* read *steter*.]

24. *Fossil Saurian Bone from Prince Edward's Island.*—Mr. J. W. Dawson describes briefly in the "Eastern Chronicle" of Nova Scotia, for June 28, 1853, a fossil bone found in sandstone, at New London, on Prince Edward's Island. The specimen is a fragment of a jaw-bone, about 7 inches long and 5 broad. It contains 8 conical teeth of various sizes, set in true sockets, the largest being an inch and a quarter in length above the surface of the jaw, and having about a fourth of an inch broken off at the summit; they are all flattened laterally, and slightly curved backwards, and are finely serrated on the edges. The teeth and bone are white, and in excellent preservation, and they are attached to the original matrix of soft red sandstone. It was found 21 feet from the surface. The rock is believed to correspond in geological age with the trias or new red sandstone.

25. *New South Wales.*—Various reports of explorations in the gold region of New South Wales, by the Rev. B. W. CLARKE, have been received by us. They are confined to local details, and afford little that we can extract to advantage. The explorations were mainly along the Australian Alps, where the rocks are granite, and various slates, the latter often much contorted. The region is in many parts much intersected by trap dykes. We hope to receive a general review of the subject from the author who is indefatigable in his explorations.

II. ZOOLOGY.

1. *Neue Denkschriften der allgemeinen Schweizischen Gesellschaft für die gesammten Naturwissenschaften.* Zurich, 1850. Vol. xi.—Though published three years ago we notice this volume now, in order to refer to two important papers contained in it; one by Prof. O. Heer, upon the fossil insects of Oeningen and Radeboy, the other by L. Rütimeyer upon the nummulitic formation of Switzerland, with a detailed description of the nummulites of that geological period. L. A.

2. *Memorias dela real Academia de Ciencias de Madrid.* Madrid, 1851. Vol. i, part 1 and 2.—Contains several valuable papers upon the Geology and Zoology of Spain. L. A.

3. *Catalogue of the Cabinet of Natural History of the State of New York.* Albany, 1843. 8°.—The Regents of the University deserve great credit for directing the publication of this catalogue. Nothing is better adapted to secure permanently the interest for public collections, and to contribute to their increase than the circulation of such catalogues. We only regret that no more direct reference is made to the individual specimens described and figured in the Natural History of New York. The importance of preserving such records to favor the researches in

case of doubts, upon the identity of a newly discovered species, cannot be overrated, and we would particularly call the attention of all the directors of Museums to this point. The chief value of many of the museums of Europe arises from the circumstance that they contain the original specimens described by the naturalists who have brought our science to its present condition. In this respect, we cannot commend too highly the catalogues of birds and eggs, published by the Academy of Nat. Sciences, of Philadelphia, drawn up by John Cassin and A. L. Heerman, Esq. L. A.

4. *Bulletin de la Société impériale des Naturalistes de Moscow, publié sous la redaction du Dr. Renard.* Moscow, 1852. 8°.—This periodical contains papers upon almost every department of Natural History. L. A.

5. *Jahresbericht des naturwissenschaftlichen Vereins in Halle.* Berlin, 1852. 8°—Touches upon a variety of topics in various departments of Nat. Hist. L. A.

6. *Sitzungsberichte der Kaiserlichen Academie der Wissenschaften.* Wien, 1852. 8°.—Like the proceedings of other academies, contains short abstracts of the papers presented to the imperial Academy of Science, in Vienna, embracing the whole scope of human knowledge. L. A.

7. *Wurtembergische naturhistorische Jahreshefte.* 9th vol, Stuttgardt, 1853. 8°. Conducted by Prof. H. v. Mohl, Pr. Flieninger, Pr. Fehling, Dr. W. Menzel, and Pr. Krauss in Stuttgardt.—This and the preceding volumes contain very valuable papers upon Zoology, comparative Anatomy, Palæontology and Botany. L. A.

8. *Zeitschrift für wissenschaftliche Zoologie, herausgegeben von Prof. C. Th. v. Siebold ü. Alb. Kölliker.* 4th vol. Leipzig, 1853. 8°.—The most important recent Journal of comparative Zoology and Anatomy; contains numerous illustrations. L. A.

9. *De l'homme et des races humaines*, par H. Hollard. Paris, 1853. 1 vol. 12°.—A work intended to prove the origin of all mankind from a single pair, and also to illustrate the varieties of men as derived in the course of time from a common stock. These views may satisfy those who seek merely for arguments in favor of an opinion generally received, without taking into consideration the range of facts in nature bearing upon this important subject. L. A.

10. *Die Geographische Verbreitung der Thiere*, von L. K. Schmarda. Wien, 1853. 8°. 3 parts.—The first comprehensive treatise on the geographical distribution of animals, including all classes of the animal kingdom. L. A.

11. *Histoire Naturelle des Mollusques Ptéropodes*, par MM. Rang and Souleyet. Paris, 1852. 1 vol. fol.—A beautiful monograph of all the Pteropodous Molluses known to this day, with 15 magnificent plates. L. A.

12. *Bilder aüs dem Thierleben*, von Carl Vogt. Frankfurt, 1852. 8°.—A very clever book, giving a most interesting account of investigations made upon Salpa during a residence at Nizza. Also an elaborate treatise upon the growth and formation of animals and the succession of fossils in former geological periods. This, and the other works of the author, show him to be thoroughly acquainted with the questions

now under discussion among naturalists; but we shrink with disgust from his cynicism and atheistic philosophy. L. A.

13. *Entwicklungsgeschichte des Meerschweinchens*, von Dr. Th. L. W. Bischoff. Giessen, 1852. 4°.—Another of those masterly monographs which have placed Prof. Bischoff at the head of the embryologists of our day. Nothing would contribute more efficiently to promote similar investigations in this country, than the publication of translations of his works, which the Smithsonian Institution might well undertake, for the benefit of American Naturalists. We would recommend that most of the earlier embryological works be equally translated, for no one ought to proceed in these investigations without consulting the works of Pander, Baer, Rathke, &c., &c., which are hardly to be seen in any American library, though they constitute now the basis upon which modern physiology has been renovated. L. A.

14. *Naturwissenschaftliche Reise nach Mossambique*, von W. C. H. Peters. Part 1, Mammalia, 200 pages, 4°, with 46 plates. Berlin, 1852.—In the year 1842, the King of Prussia granted to Dr. Peters the means of undertaking a scientific expedition into regions of Africa heretofore entirely unexplored by naturalists, the coast and interior of Mossambique. The volume before us contains a description of the mammalia observed during the residence of Dr. Peters in that inhospitable region. It is a full illustration of the subject, giving not only descriptions of the external appearance of the animals mentioned, but also descriptions and illustrations of the skeleton, the teeth, and sometimes even of the other organic systems. Nothing could be more welcome to zoologists than such an account of the animals of that region, so particularly interesting from its position, opposite to Madagascar, and the uncertainty which has prevailed up to this day respecting the resemblance of its inhabitants, and those of that large Island. Whether the peculiar forms of animals known to inhabit Madagascar, such as the Makis, were also to be found upon the opposite coast of Africa, or not, was a question no body could answer before the invaluable researches of Dr. Peters furnished us with the necessary data to contrast the two faunæ. Mossambique is now known to have a genuine African fauna. Its monkeys, six in number, belong to the genera Cercopithecus, and Cynocephalus. No genuine *Makis* have been observed, and only one species of Otolicnus, a genus which has also its representative in Western Africa. This is the more interesting since Dr. Peters observed two Makis alive from Anjoana, one of the Comoro Islands. The minuteness of the descriptions of Chiroptera and Insectivora deserves particular notice, for many of the species of these families enumerated in our systems cannot be recognized from want of sufficient accuracy in the details given of their characteristics. He enumerates not less than eighteen species of Chiroptera, belonging to the genera Pteropus, Cynonycteris, Epomophorus, Phyllorhina, Rhinolophus, Nycteris, Emballonura, Taphozoas, Dysopes, Vespertilio, Nycticejus, among which there are several belonging exclusively to the continent of Africa. Of Insectivora the number is nine, belonging to the truly African genera Chrysochloris and Macroscelis, to the cosmopolite genus Sorex, and to two genera, Petrodromus and Rhyncocyon, first described by Dr. Peters himself, from Mossambique. How truly African this country is,

appears, perhaps, still more distinctly from its carnivorous animals, among which we notice the lion, the leopard, the spotted hyena, several ichneumons, &c., altogether nineteen species, some of which are new, belonging to the genera Herpestes and Bdeogale. One species of Viverra, the Rasse of Horsfield, observed upon Anjoan, furnishes another evidence that even the small islands east of the African continent partake more of the Zoological character of the East Indies and Madagascar, than of Africa itself. Of gnawing animals, twenty-three species were observed, belonging to the genera Sciurus, Myoxus, Meriones, Mus, Acomys, Cricetomys, Hystrix, and Lepus, and to four new genera, Heliophobius, Pelomys, Steatomys, and Saccostomus. It is interesting to notice among these many Glires a new southern species of the truly African genus Hystrix. Most of these animals are handsomely illustrated, and their skulls and dental system represented with all the required minuteness. The Edentata number a single species of Manis, identical with that of the Cape of Good Hope. The only wild horse, Equus zebra, has long been known from other parts of the continent. How numerous the elephants must be, can readily be estimated from the statement of Dr. Peters, that about ten thousand of these animals are annually killed for their ivory. The most common rhinoceros is the same as that of the cape, first described by Camper as Rh. africanus, Cuvier's Rh. bicornis; another species is Rh. Simus. The Hippopotamus is very common in all the fresh waters of Mossambique. Besides these Pachyderms, one species of Phacochœrus, and one of Hyrax are noticed. Among ruminants, the giraffe is wanting, nor are even domesticated camels ever seen in Mossambique, but the antelopes occur very extensively, and several new species are described. Domesticated goats, sheep, and cattle have been introduced from the Comoro Islands and from Madagascar. Some varieties of sheep have been imported from the East Indies and even from America. The wild bull of Mossambique is Bos caffer, a species formerly found as far south as the Cape. Of Cetacea, the Dugong, Halicore indicus, inhabits almost the whole eastern coast of Africa. The sperm whale, Physeter macrocephalus, is said to have been very common in the Canal of Mossambique; it is now rare there, as are also other Cetacea.

It is to be hoped that the next volumes of this Fauna of the Oriental coast of Africa will soon follow the first. We may look forward to a great zoological treat, in becoming acquainted with the fishes of the Zambese. Such works furnish invaluable contributions not only to special zoology, but also to the geography of animals, and are equally creditable to their authors and to the governments patronizing such costly publications. L. A.

15. *On the Osteology of the Head of Hippopotamus, and a description of the Osteological characters of a new genus of Hippopotamidæ*; by Jos. Leidy, M.D. From the Journal of the Acad. of Nat. Science of Philadelphia. N. S., vol. 2, p. 3.—In this interesting paper Dr. Leidy shows that the Hippopotamus of Senegal, and that of the Cape of Good Hope, first considered as distinct species by Desmoulins and Duvernoy, differ truly specifically, and that the third species described by Dr. Morton as Hippopotamus liberiensis is not only specifically distinct, but constitutes a distinct genus, for which the name Chœropsis is proposed.

L. A.

16. *Museum Heineanum: Verzeichniss der ornithologischen Sammlüng des Oberamtmann Ferd. Heine*, von Dr. JEAN CABANIS. Halberstadt, 1850–51. 8°.—Invaluable as far as a correct synonymy is of importance in the study of Natural History. The author objects justly and energetically to the practice now prevailing of separating the specific from the generic name in the quotations of authorities. Upon this point see also the introduction to my Nomenclator Zoologicus. L. A.

17. *Journal für Ornithologie*, von Dr. JEAN CABANIS. 1853. 8°.—The first number of a Journal devoted exclusively to Ornithology, published with the coöperation of the most prominent ornithologists of Europe, by Dr. Cabanis, keeper of the Zoological Museum in Berlin. L. A.

18. *Analecta ad Entomographiam provinciarum occidentali meridionalium imperii rossici;* auctore S. B. GORSKI. Fasc. 1. Berolini, 1852. 8°.—A monograph of the Neuropterous Insects, and the description of some new species of Hymenoptera of south eastern Russia. L. A.

19. *Monographia Pneumonopomorum viventium;* auctore L. PFEIFFER. Casselis, 1852. 8°. 1 vol.—A complete monograph of the pulmonate Gasteropods, provided with an operculum. L. A.

20. *Illustrations of the Birds of California, Texas, Oregon, British and Russian America:* intended to contain descriptions and figures of all North American birds, not given by former authors, and a general synopsis of North Amerian ornithology. To be completed in 30 parts each part to contain 5 colored plates; by JOHN CASSIN. 8vo. Philadelphia, 1853. Lippincott, Grambo & Co.—A very handsome number, with beautiful plates. The synopsis of Parinæ is given as a specimen of the manner in which the species not described will be mentioned; and it includes also descriptions and figures of the species *Cyanocorax luxuosus*, or Mexican Jay, the *Melanerpes formicivorus*, or Californian Woodpecker, the *Lophophanes atricristatus*, or Black-crested Chickadee, the *Cyrtonyx Massena*, or Massena Partridge, *Larus Heermanni*, or White-headed Gull. The work is highly important, and will add a new value to those published before, by other writers, upon the natural history of birds of North America. If completed in the style begun, it will be a most valuable addition to the natural history of the United States. L. A.

Subscriptions to the work are solicited by the publishers.

21. *Versuch einer Monographie der Lycænen, als Beitrag zür Schmetterlingskunde mit Abbildungen nach der Natur*, von BERNHARD GERHARD. Hamburg, 1853. 4°. Nos. 9 and 10.—The concluding numbers of a monograph of one of the most variable and difficult groups of Lepidoptera. L. A.

22. *Notes on the Classification of the Carabidæ of the United States;* by Dr. JOHN L. LE CONTE. From the transactions of the American Phil. Society. Vol. x. 1853.—We regret not finding time for the present to read and review the many special entomological papers Dr. Le Conte has published recently; but we cannot pass entirely unnoticed one upon the classification of the Carabidæ, which contains a thorough discussion upon the most prominent features of this difficult family, and the natural limitation of its subdivision and the characteristics of its genera, with a complete revision of the North American species. L. A.

III. Astronomy.

1. *Shooting Stars of August* 10, 1853.—The observations here recorded were made at New Haven, Conn., by Messrs. Francis Bradley and Lyman Baird, with myself, on the night of Wednesday, August 10, 1853. We were stationed together, in the open air, each observer having in his view, as far as practicable, a third part of the visible heavens. The time was highly favorable, the air being clear and calm, and the moon absent. Systematic observations were commenced at midnight, and continued until 3h. 25m. A. M. of the 11th, and the following table shows the number of different shooting stars seen by us during this period :

			S.	N. N. W.	E. N. E.	TOTAL.
0^h	to 1^h	A. M.	48	27	35	110
1	" 2	"	42	34	39	115
2	" 3	"	57	31	31	119
3	" 3 25^m	"	26	7	11	44
						388

Besides the meteors above enumerated, we saw about twenty during the quarter of an hour preceding midnight, rejected fifteen or twenty doubtful cases, and lost some after three o'clock on account of advancing daylight, and other causes. No meteor was twice reckoned, although many were of course seen in common by two observers.

Of these meteors the large majority, probably not less than three-fourths, moved in paths which traced back would intersect very near the cluster in the sword-handle of Perseus, and during our observations this apparent radiant place did not change its position among the stars. Many of the meteors left trains behind them, and exceeded in brilliancy stars of the first magnitude, while a few equalled in splendor the planet Venus.

It is evident from the foregoing statements that the periodical meteoric display of August 9–10th has appeared this year in usual form, and in numbers not much diminished. In order to render the numbers above given comparable with those of former years when four observers were on the watch, about one-sixth should probably be added thereto.

It may be worthy of mention, that slight manifestations of the *Aurora Borealis* were visible about 2 A. M. of the 11th, for about fifteen minutes, and again about 3 A. M., the light being in each case an irregular patch, extending from two to five degrees above the horizon, and wholly on the west of the north point.

As early as 2h. 15m. A. M. it was certain that there was some unusual though faint illumination along the northeastern horizon. As the morning advanced this illumination became brighter, and was recognized as the *Zodiacal Light*; but it was impossible to describe its outline, or to decide on the place of its termination. It extended from the N. E. horizon, covering the stars *Castor* and *Pollux*, stretching upwards and onwards to the vicinity of *θ Aurigæ* and *β Tauri*, while no trace of the light could be discerned south of the ecliptic. The sky in this quarter seemed to be somewhat hazy.

During the night of Tuesday, the 9th inst., the sky was too cloudy for observation.

E. C. Herrick.

2. The planet discovered on the 5th of April, by Professor Gasparis, has been named Themis, with the sign (24).

3. *Phocea*, (25) (Compt. Rend. xxxvi, 991.)—The following elliptic elements of this planet have been communicated by M. Valz :—

Epoch, 1853, May 1·486.

Mean anomaly,	305° 17′
Long. of perihelion,	303 14
" asc. node,	214 0
Inclination,	21 24
Excentricity,	0·24441
Semi-axis maj.,	2·3762
Mean daily motion,	968″·70

4. The planet discovered on the 5th of May last, by Mr. Luther, has been named *Proserpine ;* its sign is (26).—*Compt. Rend.*, xxxvi, 1015.

5. Third Comet of 1853, (Astron. Journ.)—*Mr. Klinkerfues*, assistant at the Göttingen Observatory, detected a small comet on the 10th of June. At $13^h\ 0^m\ 54^s$, its position was R. A. 143° and N. Decl. 43°·5. It had a tail 3′ or 4′ in length. The following elements are given by *Bruhns* :—

Perihelion passage,	Aug. 27·213	M. T. Berlin.
Long. perihelion,		310° 31′ 12″·1
Place of asc. node,		140 50 27 ·6
Inclination,		59 54 23 ·1
Log. perihelion dist.,		9·491256

Motion direct.

IV. Miscellaneous Intelligence.

1. *American Association for the Advancement of Science.*—The seventh meeting of the American Association was held at Cleveland, during the week following the 28th of July. Prof. B. Peirce, of Cambridge, was President for the year. The meeting was less well attended than those of former years, owing partly to the engagements of many of the members of the Association at the different institutions of the country, with which they are connected. Among the papers presented, those of the departments of Physics and Mathematics were much the most numerous, and were mostly of high merit. There were but few papers brought forward in Geology, or Chemistry. The meeting adjourned on Tuesday, the 2d of August, to meet in Washington, on the last Wednesday of April, 1854.

A committee for revising the constitution of the Association was appointed, consisting of Prof. Bache, Dr. J. Lawrence Smith, Dr. Le Conte, of Georgia, Dr. W. Gibbs, of New York, Dr. B. A. Gould, Jr., Prof. W. B. Rogers, Prof. J. D. Dana, Dr. J. Leidy, Prof. S. S. Haldeman, and Dr. A. A. Gould. Resolutions were passed reducing the annual assessment from $3 to $1, and requiring that the Proceedings should be furnished to members at cost, or free of expense when the Proceedings are published by the public liberality of the city where the meeting may be held.

The following officers were appointed for the ensuing year: Prof. J. D. DANA, President; Prof. J. LOVERING, of Cambridge, General Secretary; Prof. J. LAWRENCE SMITH, Permanent Secretary, and Dr. ELWYN, Treasurer.

Dr. B. A. Gould, Jr., was requested to prepare an obituary of the late Sears C. Walker, to be presented at the meeting at Washington.

The following is a list of the papers read at the Cleveland meeting. We deem it the only just course to authors not to publish abstracts of their papers, unless such abstracts are made out by themselves, and sent to us expressly for publication.

(1.) *Physics, Mathematics, Astronomy.*

Prof. B. PEIRCE, of Cambridge, Mass.: Investigations in Analytical Morphology: No. 1, Description of the Science; 2, Stable and Unstable forms of Equilibrium; 3, forms of the Elastic Sac; 4, Stability of Saturn's Ring.

——— Personal Scale of Astronomical Observers.

——— Criterion for the rejection of doubtful observations.

——— Theory of the action of Neptune upon Saturn.

Prof. A. D. BACHE, Supt. Coast Survey, Washington: On the Tides at Key West, Florida, from observations made in connection with the U. S. Coast Survey.

——— On the Tides of the Western Coast of the United States, from Observations at San Francisco, California, in connection with the U. S. Coast Survey.

Prof. STEPHEN ALEXANDER, of Princeton: On some special analogies of Structure in the Eastern Hemisphere of the Earth and the visible Hemisphere of the Moon, with conjectures as to the Structure and Appearance of those portions of the Moon which are invisible.

——— On some Relations of the Central Distances of the Primary Planets, Satellites, and Rings of the Solar System, of which Bode's Law would seem to be but an imperfect expression.

——— On the Primitive Form and Dimensions of the Asteroid Planet, the cause of the Instability of the same, and of the Varieties in the Orbits of the Asteroids.

Prof. W. CHAUVENET, of the U. S. Naval Academy: On the Method of finding the error of a Chronometer by equal altitudes of the sun.

——— New Formulas of Spherical Trigonometry.

Dr. B. A. GOULD, Jr., of Cambridge, Mass.: On Personal Equations in Astronomical Observation.

——— On the Velocity of Transmission of Electric Signals along Iron Telegraph Wires.

——— On the comparative precision of the Electro-chronographic or American Method of Observation.

Prof. O. M. MITCHEL,: On a New Method of securing Uniform Circular Motion in the Machinery used in receiving the Registration of Astronomical Observations of Right Ascension.

Prof. C. W. HACKLEY, of New York: Mathematical Analysis of the contact of surfaces in oscillating Machinery.

Lt. E. B HUNT: On Cohesion of Fluids, Evaporation, and Steam Boiler Explosions.

——— The Conical Condenser, a Telescopic Appendage.

Prof. JOHN H. C. COFFIN, of the Washington Observatory: Some errors peculiar to the observer, which may affect determinations of the declinations of the Fixed Stars.

Dr. JULIUS FRIEDLÄNDER, of Berlin: On the limit toward which the series,

$$1+\frac{1}{2^{1+p}}+\frac{1}{3^{1+p}}+\frac{1}{4^{1+p}}+\text{\&c.},$$

converges for $p=0$.

Prof. O. N. STODDARD, of Miami University: Strictures on the mechanical explanation of the zig-zag path of the Electric Spark.

Prof. J. L. RIDDELL, of New Orleans: Theory of Molecular Forces, explanatory of the gaseous, liquid, and solid conditions of matter.

Prof. JOSEPH HENRY, of Washington: Illustrations of Cohesion.

Prof. JOSEPH LOVERING, Cambridge: On a Modification of Soleil's Polarizing Apparatus for Projection.

——— On a singular case of internal Fringes, produced by interference in the eye itself.

Prof. GEO. R. PERKINS: Description of a plan for furnishing a Fluid Mirror, to be used in a Reflecting Telescope.

D. VAUGHAN, of Cincinnati: The Zodiacal Light, the periodical appearance of Meteors, and the point in space to which the motion in the Solar system is directed.

(2.) *Meteorology.*

W. C. REDFIELD: On the value of the Barometer in navigating the American Lakes.

Prof. E. LOOMIS, of New York: Does the Moon exert a sensible influence upon the Clouds?

——— Notice of a Hail Storm, which passed over New York, July 1, 1853.

J. H. COFFIN, of Easton, Pa.: An Investigation of the Storm Curve, deduced from the Relations existing between the direction of the Wind, and the Rise and Fall of the Barometer.

LORIN BLODGET, of Washington: On the Barometric Pressure in extreme Latitudes, and the existence of Belts of low Barometer in the Arctic Regions.

——— On the South East Monsoon of Texas, the Northers of Texas and the Gulf of Mexico, and the abnormal Atmospheric Movements of the North American Continent generally.

——— On the distribution of Heat over the North American Continent, and the construction of its Isothermal Lines.

——— On the Subordination of Atmospheric Phenomena, or the Position of the several Classes with respect to the primary Cause or Initiatory Processes.

——— On the distribution of precipitation in Rain and Snow on the North American Continent.

Prof. A. D. BACHE, Supt. U. S. Coast Survey, Washington: On the Winds of the Coast of the United States on the Gulf of Mexico.

Prof. JOSEPH LOVERING, Cambridge: On optical Meteorology.

(3.) *Geology, Geography, Chemistry.*

Prof. J. M. SAFFORD, of Lebanon, Tenn.: On the parallelism of the lower Silurian groups of Middle Tennessee with those of New York.

W. C. REDFIELD, of New York: On the Geological Age and Affinities of the Fossil Fishes which belong to the sandstone formations of Connecticut, New Jersey, and the coal field near Richmond, in Virginia.

A. WINCHELL, of Eutaw, Alabama: On the Geology of the Choctaw Bluff.

Dr. J. A. WARDER, of Cincinnati: A Geological Reconnoisance of the Arkansas River.

J. S. NEWBERRY, M.D., of Cleveland: On the Structure and Affinities of certain Fossil Plants of the carboniferous era.

——— On the Carboniferous Flora of Ohio, with descriptions of fifty new Species of Fossil Plants.

——— On the Fossil Fishes of the Cliff Limestone of Ohio.

Prof. J. BRAINERD, of Cleveland: Origin of Quartz Pebbles in the Sandstone Conglomerate, and the Formation of the Silicious Stratified Rocks.

L. F. POURTALES, Ass't in Coast Survey. Presented by Prof. BACHE, Superintendent: Notes on the Specimens of the bottom of the Ocean, brought up in recent explorations of the Gulf Stream, in connection with the Coast Survey.

Prof. BACHE, Supt.: Recent Discovery of a Deep-sea Bank on the eastern side of the Gulf Stream, off the Coast of South Carolina, Georgia and Florida, by Lieuts. Commanding Craven and Maffit, U. S. N., Asst's Coast Survey.

Dr. F. A. GENTH and Dr. W. GIBBS: On a remarkable class of conjunct bases containing Cobalt and the Elements of Ammonia.

Prof. E. N. HORSFORD: On the Solidification of the Coral reefs of Florida and the source of Carbonate of lime in the growth of corals.

(4.) *Zoology and Botany.*

Dr. W. I. Burnett, of Boston: On the Blood Corpuscle—holding Cells, and their relation to the Spleen.

——— On the Formation and Mode of Development of the Renal Organs in Vertebrata.

——— On the Formation and Functions of the Allantois.

——— Researches on the Development of the Viviparous Aphides.

——— On the Reproduction of the Toad and Frog, without the intermediate stage of Tadpole.

——— On the Signification of Cell Segmentation.

Prof. J. Riddell, New Orleans: On the Histology of Red Blood.

——— On the Origin of Capillary Blood Vessels.

——— On the Structure and Trans-formation of Oscillaria aureliana.

S. N. Sanford, of Granville, Ohio: On some points in the History of Gordius.

R. Howell, of Nichols, New York: On the Wheat Fly, and its Ravages.

Prof. Alphonso Wood, of Cincinnati: On Six New Species of Plants.

(5.) *Miscellaneous.*

Prof. E. Loomis, of New York: On the Measurement of Heights by the Barometer.

Prof. John Brocklesby, of Trinity College, Hartford: On the Rising of Water in Springs immediately before Rain.

W. H. B. Thomas, of Cincinnati: Indications of Weather, as shown by Animals and Plants.

Prof. E. N. Horsford, of Cambridge, Mass.: On the fatal effects of Chloroform.

Prof. S. S. Haldeman, of Columbia, Pa.: Investigation of the power of the Greek Z, by means of Phonetic Laws.

Loren Blodgett, of Washington: On the Earthquake of April 29, 1852.

Lt. E. B. Hunt: Remarks on Lithography and Lithographic Transfers.

——— Project of a Geographical Department of the Library of Congress.

Prof. J. L. Riddell, New Orleans: On the Binocular Microscope.

Capt. Wilkes: Account of Experiments on Sound.

——— Notice of Bradford's Machine for separating metals by their specific gravity.

Andrew Brown, of Natchez, Miss.: On the effect of the Reclamation of the annually inundated Lands of the Mississippi Valley upon the general Health of the country, and the navigation of that River.

Rev. P. R. Lynch, of Charleston: The Artesian Well, Charleston.

Herman Haupt, Supt. of the Pennsylvania Central Railroad, Philad.: On the Resistance of the Vertical Plates of Tubular Bridges.

2. *Note, by Prof.* Barnard, *to p.* 224, *on the effect of Moisture on the Heat dereloped by Compression of Air.*—In making this computation, no account is taken of the hygrometric state of the air; because, according to the tables of Gay Lussac and Regnault, the ordinary tension of the vapor present in the atmosphere is only $\frac{1}{110}$ of the total elasticity, or less than ·3 of an inch of mercury. This vapor cannot affect the power of the engine one way or the other; since its coefficient of expansion by heat is the same as that of air. If it existed in a more appreciable quantity, however, it would increase the consumption of heat without increasing the labor performed; for the twofold reason that the specific heat of watery vapor (by weight or by *volume*) exceeds that of air, (*Regnault, Comptes Rendus*, Apr. 18, 1853,) and the γ, for vapor, according to Dulong, is as high as 1·5, (*Péclet, Traité Elementaire de Physique.*)

3. *Note, by Prof.* Barnard, *to p.* 225, *on the Heat required to convert Water into Steam.*—The (so-called) *latent* heat of steam, has been very differently stated by different experimenters. Poisson (*Traité de Me-*

canique) puts it at 550° C., adopting the determination of Désormes and Clement as a mean. As 560° C. =990° F., we have

$$990°+212°-60°=1142°,$$

for the qnantity of heat necessary to convert water at 60° into steam at 212°.

4. *Note to p.* 226, *on the Theoretic Determination of the Expenditure of Heat*; by Prof. BARNARD.—A partial compensation for this expenditure, arising from expansion after cut-off, overlooked in the text, seems to be of sufficient importance to deserve attention in this postscript note. When the supply cylinder is less than the working cylinder, the density of the heated air is, at the end of the stroke, necessarily, in the same ratio, less than unity. In this case, it is $\frac{2}{3}$. Now this air cannot be discharged at a less pressure than that of the atmosphere; and, in the general formula,

$$p'=p\left(1+\frac{\theta}{519}\right)\varrho,$$

If we put $p'=p$, and $\varrho=\frac{2}{3}$, $1+\frac{\theta}{519}$ must be equal to $\frac{3}{2}$; or $\frac{\theta}{519}$ to $\frac{1}{2}$. That is, θ must be 259°·5 above the initial temperature, (60° F.) or 289°·5 above 32° F.

The temperature in the working cylinder, after expansion, is 322°·2. As the air passes the regenerator (supposing this contrivance to absorb all the sensible heat above that which is due to compression =116°·54) its density will remain unchanged while it cools from 322°·2 to 287°·5. But from 287°·5 to 116°·54, the atmospheric resistance increases the density; and the cooling takes place as *under constant pressure*. Through 170°·96, therefore, (=287°·5−116°·54) the air imparts to the regenerator the calorific equivalent of K_p and not of K_v for every degree of cooling and every unit of mass.

Now 170°·96×·36=61°·5456, which should be deducted from the apparent consumption, as given in the text; leaving the actual theoretic consumption, an amount representable in mechanical equivalents, by

$$186{\cdot}3\ MK_v=136{\cdot}98\ MK_p=82{\cdot}56\ MK_w.$$

Putting M=46·82 lbs., we find the consumption of heat to be sufficient to raise one pound of water 1524°·5 F., or to convert 1·335 lbs. into steam at 212°, which is adequate to raise 76·880 lbs. one foot, and makes the power of steam to that of air, as 1 : 5·81.

Allowing the steam an equal expansion, the ratio becomes 1 : 4·556.

The relative *theoretic* economy of steam and heated air employed as motive powers is apparently, therefore, not materially affected by varying the ratio of the supply to the working cylinder.

5. *On a Native Boro-titanate*; by Prof. J. LAWRENCE SMITH.*—This interesting compound has been known for some time to American mineralogists, having been first described by Prof. C. U. Shepard, under the name of Warwickite, and considered as a hydrated silico-titanate of magnesia, iron and alumina. It was afterwards described by Mr. T. S. Hunt under the name of Enceladite, and in his last analysis

* This important paper was received at too late an hour to be inserted earlier in this volume.—EDS.

(this Jour., [2] xi, 352,) considered a tri-titanate of magnesia. In the reëxamination of American minerals, in which Mr. Brush and myself are engaged, this mineral came up in turn for examination, and to our amazement, it is found to contain a large amount of boracic acid, doubtless upwards of 20 pr. ct. Approximative analysis are already made, but owing to the difficulty of obtaining it of sufficient quantity in a perfect state of purity, its final examination may be delayed for some time; and it is for that reason thought advisable to publish the present note on the subject. It is essentially a borotitanate of magnesia and iron; the metallic acid, however, has some anomalies about it, not yet cleared up. This is the first borotitanate known, and as such highly interesting, the smallest portion of it, when acted on with sulphuric acid, will give the strongest indication of the presence of boracic acid.

6. *A Supposed Earthquake*, (Northern Journal, Lowville, N. Y., March 16, 1853.)—At Lowville, N. Y., and in its vicinity, early on the morning of Saturday, (between 2 and 3 o'clock,) on the 12th of March, there was a shock like an earthquake. It commenced with a heavy distant rumbling sound, apparently beneath, which gradually increased, and at its maximum broke out in a grand explosion, louder than the loudest thunder. There were other reports, but it diminished, and ended with the same heavy rumbling with which it begun. Houses were shaken so that dishes and furniture were displaced, and the bell of the church struck nine or ten times. The academy bell also rung, although less high. One chimney was thrown down. The people were all aroused and many rushed to the streets. The editors of the paper from which we cite, ask, "Was it an earthquake; or a concussion of the atmosphere, produced by some meteor or aerolite?" and then gives reasons for believing it an actual earthquake, viz: the subterranean character of the sound, the motion of the earth, the absence of any light or flash, and no sudden barometric change.

The direction is stated at from east to west, or the reverse. It was felt at Turin and Copenhagen quite heavy, at Adams heavy, at Watertown slight, at Remsen, Trenton, and Holland Patent not at all. The wind was southeast. The preceding day had been clear, but at 10 in the evening of Friday, the sky became overcast, and unusual darkness prevailed, which continued till the time of the occurrence. The thermometer and barometer gave the following observations:

		Thermometer.	Att. Thermometer.	Barometer.
Friday,	6 A. M.	30·0	45 0	29·252
	2 P. M.	39·5	53·0	29·205
	10 P. M.	27·0	60·0	29·220
Saturd'y	2·30 A. M. time of shock	34·0	52·5	29·140
	6 A. M.	32·5	47·8	29·095
	2 P. M.	40·5	57·0	28·975

7. *Observations on Atmospheric Pressure*; by Lieut. M. F. Maury, (Proc. Acad. Nat. Sci. Philad., vi, p. 313.)—Lieut. M. F. Maury, through Dr. Le Conte, the Corresponding Secretary, presented an engraved diagram, representing a "vertical section of the basin of the Atlantic," about the parallels of 39° and 40° north latitude, the data for which drawing are furnished by the deep sea soundings, taken by officers of the U. S. Navy, in obedience to an order from the Navy

Department. Lieut. Maury says, "These data are not very abundant, but such as they are they give a proximate idea as to the submarine depression."

The diagram exhibits a striking contrast between the profile of the earth's crust above and below the sea level.

The same plate represents a vertical section across the continent of South America from Lima, on the Pacific, to the mouth of the Amazon under the equator, on the Atlantic.

The object of this part of the engraving is to illustrate certain anomalies in the pressure of the atmosphere, as inferred from the experiments of Lieut. Herndon, U. S. Navy, on the boiling point of water, during his recent journey across that section of the continent. The following extract from a table shows the boiling points at several places on the route, and their elevations above the sea respectively :

Heights of Places determined by Lieut Herndon, U.S.N.

NAMES OF PLACES.	Distance in statute miles from Lima	Boiling point.	Heights above the level of the sea.
Brought forward, . .	352		
La Cueva, ...	20	206·5	2595 feet.
Lingo Maria, ...	10	207·8	1923 "
Land travel, . . .	382		
Focache, ...	174	209·1	1253 "
Sion, ...	58	209 7	944 "
Lupuna, ...	58	210·	791 "
Chasuta, ...	87	210·5	585 "
Santa Cruz, ...	220	211·2	177 "
Nanta, ...	353	211·3	126 "
Petras, ...	197	211·1	228 "
Egas (904)	707	208·2	1715 "
River Bank, ...	131	208·4	1611 "
"	60	208·5	1560 "
"	163	208·6	1507 "
"	50	208·8	1406 "
Barra, ...	14	209·3	1150 "
Mouth of the Madeira, . . .	104	209·8	893 "
Villa Nova, ...	209	210·3	638 "
Santarem, ...	220	210·5	535 "
Pará, ...	759	211·5	25 "
Sea, ...	93		
Direct water travel, . . .	3652		

A dotted line on the diagram represents Lieut. Herndon's track above the level of the sea, according to the above experiments. "By this track it will be perceived," says Lieut. Maury, "that after ascending the Andes, and coming down the Amazon to a considerable distance, he ascended or went up hill. Now we know that this was not the case, because he was all the time drifting down the stream in a canoe. To reconcile this apparent paradox between the inclination of this slope of the continent, as shown on the one hand by the running water of the rivers, and on the other by the pressure of the air, it is necessary to suppose, that when he boiled his water at the eastern base of the Andes, he was in fact under a bank of atmosphere, and that the pressure under this bank was so great as to force the boiling point up very nearly to the sea level.

Let us now proceed to account as best we may, for this bank, or increased atmospheric pressure.

These experiments were made in south latitude, and in the trade wind region of that hemisphere. These winds strike nearly perpendicularly against the Andes, the tops of which range extend in many places nearly, if not quite as high, as do the trade winds themselves. Now, then, what is the effect of such an obstruction as the Andes afford to the passage of the south east trade winds? If we may judge by the effect of similar obstructions to running water, we have no hesitation in saying that the effect is to bank up.

Pot Rock and other obstructions to the rapid current of Hurlgate—taking small things to represent great—may serve us with an illustration that will assist me in making myself clear. Any one who witnessed the water running over that rock, could not fail to be struck with the fact, and the extent to which the water was piled up, not *over* the rock, but *up stream* from it; not only was there this banking up of the water, before it reached the rock, but there was also a depression *above*—that is, up stream from this bank of water on the one hand, and below or down stream from the rock on the other.

In like manner it appears to me, that Herndon's observations have revealed the fact that there is, at times at least, in the intertropical atmosphere of South America, an air-cast mould of the Andes.

It is remarkable how clearly these observations indicate a piling up of the atmosphere to the windward of the Andes, and a depression in the general atmospheric level to the windward again of this air bank. If this conjecture afford the real explanation of the phenomena, we should look on the lea side of the Andes for a low barometer, or a depression in the atmosphere, corresponding to the hollow in the water below Pot Rock.

The mean height of the barometer in Lima, as far as I have been able to ascertain it, indicates that such a depression is perceived there.

If subsequent observations should confirm these indications and establish them as realities, we should then be put in possession of important physical facts. We should be led to infer that the height of mountains, and of mountain slopes above the sea level, as determined by the barometer, would depend somewhat upon *which way the wind blows*, and the only safe rule of admeasurement in such cases, would be to establish a standard barometer at the foot of the mountains, both on the windward and the lea side.

Another of the physical facts besides that of establishing the direction of the wind, as a function in barometric determination is, that if this increased pressure of the atmosphere at the eastern foot of the Andes be caused by the obstruction which that range of mountains affords to the passage of the trade winds, then do those mountains in the trade wind region become a natural anemometer, which will give us in terms of the barometer an expression for the whole amount of force employed in giving motion and velocity to the trade winds of the earth.

8. *Were the Ancient Egyptians acquainted with Nitric Acid?* by Thornton J. Herapath, Esq., (Lond. Edin. and Dublin Phil. Mag., v, p. 339.)—In the Supplement Number of the Philosophical Magazine for July last, my father published a paper on "Early Egyptian Chem-

istry," in which he gave a short account of some experiments he had made on certain hieroglyphical marks or letters that had been discovered on the wrappers of a mummy which was recently unrolled by Mr. Nash at this Institution; and he then stated it was his belief that the ancient Egyptians were acquainted with a marking fluid containing nitrate of silver for its basis, and were also familiar with the use of nitric acid. A short time afterwards, Mr. Denham Smith, in a reply to this letter, took exception to my father's views on the subject; and whilst admitting the interesting nature of the discovery that had been made of an argentine solution having been employed some three thousand years ago as 'marking ink,' totally dissented from the conclusions that had been founded on it, inasmuch, he said, as there was no evidence to prove that the Egyptians were even acquainted with the art of distillation. He also hazarded the opinion, unsupported, however, by direct evidence, that the marking-fluid in question was prepared—if I understand him aright—by dissolving either the chlorid or oxyd of silver in an ammoniacal solution, and consequently without the intervention of any acid whatever. As the question in dispute is one of considerable interest in a scientific point of view, I determined to subject the marks to a fresh examination. After making several preliminary experiments, I found that no results of any value could be obtained by the ordinary modes of analysis, and was therefore compelled, as a last resource, to call in the assistance of the microscope.

Upon examining some of the fibres of the bandages that were stained by the argentine ink, I found them to present a very peculiar appearance. The ends nearest the corroded parts of the fabric were stained of a deep brown or black; but for some little distance beyond the blackened portion the fibre was colored of a pale yellow hue, as if, during the decomposition of the silver salt that had been employed as 'marking-ink,' nitrogenous constituents of the tissue had been partially acted upon and converted into xanthoproteic acid.

Between several of the fibres, and in many places adhering to their external surfaces, were found small particles of some organic tissue, which were colored of a still deeper yellow than the fibres themselves. On subjecting some of the latter to the action of strong *liquor ammoniæ*, the yellow portions, particularly the altered intercellular substance, acquired a still darker hue, whilst those on the contrary, which were stained by the reduced silver became somewhat paler, as if a portion of the argentine film were soluble in that menstruum; though it should be observed, that no further effect was produced on the stain even by a protracted digestion in ammonia. Now, upon making comparative experiments with a piece of the linen wrapper that had been recently 'marked' in the usual way with a solution of nitrate of silver, the fibres were found to present a very similar appearance to that before described; the only difference being that the yellow coloration was not quite so distinct, and more of the silver stain was removed by the solution of ammonia; whereas, on the other hand, fibres that had been stained by solutions of chlorid and oxyd of silver in ammonia were uniformly colored of a dark brown or black, and exhibited no trace of yellow coloration.

These results, conjoined with the corroded state of the linen in the vicinity of the marks, justify us, I think, in concluding that the ancient Egyptians were really acquainted with nitric acid; and, as my father has already suggested, employed the nitrate of silver as a marking-fluid. In what manner, however, they prepared the acid, whether by the distillation of the nitrate of soda or nitrate of potash with oil of vitriol, or by one of the processes adopted by the alchemists, I will not at present attempt to decide, but will leave the problem to be solved at some future period, when the researches of antiquarians shall have offered us further evidence on the subject.

9. *California Academy of Natural Sciences.*—An Academy of Natural Science has recently been instituted at San Francisco, California, having for its objects the collection of specimens in various departments of science, and lectures and publications on scientific subjects. A Randall, Esq., has been elected President, H. Gibbons and T. J. Nevins, Vice Presidents, W. P. Gibbons, Corresponding Secretary, L. W. Sloat, Recording Secretary, A. B. Stout, Treasurer.

10. *Aurora seen at Perryville, on the 24th of May*, 1853; by Prof. G. W. Wheeler.—At a quarter before nine, P. M., May 24th, a bank of white light lay along the northern horizon, elevated perhaps 10° due north, and extending about 100° on the horizon.

Nine o'clock, streamers distinctly visible in the N. W., and a little to the E. of N.

9¼, Streamers more visible; bank less so. Some of the streamers could be traced above the pole star.

9½, Streamers not so high, but occupy almost the whole bank.

9¾, Streamers hardly perceptible; bank disappearing.

10, Bank and streamers have both disappeared

The light was white and slightly yellow, nothing of redness; the evening clear and still; thermometer 13° Cent. Perryville is in Lat. 37° 43′ 56″, Long. 89° 53′ 20″.

11. *The Great Gold Nugget*, (Athenæum, No. 1344.)—The *Times* states, that the great Australian nugget lately exhibited at Mr. Wyld's Globe, in Liecester Square, has been melted and sold by Messrs. Haggard and Pixley, bullion brokers, for 5,532*l*. Its weight before melting was 1.615 ounces; and it yielded 1,319 ounces of fine gold, equal to 1,423 ounces standard.

12. *Polytechnic College, Philadelphia.*—A Polytechnic College has been chartered by the State of Pennsylvania, to be established in the city of Philadelphia. Mining and Metallurgy, Agriculture, Manufactures, Mathematics, and Engineering, are to be its main branches of instruction. A chemical laboratory, mineralogical collections, and other appurtenances required for instruction in the practical applications of science, are included in the plan. The professorship of Metallurgy, and Industrial, Agricultural, and Analytical Chemistry, (a large range for one man,) is stated to be filled, but the three other departments proposed are yet to be provided with Professors.

13. *Notice to Naturalists.*—The Cabinet of the late Dexter Marsh will be offered at public auction, on Wednesday, the twenty-first day of September next. It embraces a great variety of natural objects; but its peculiar value consists in its unrivalled collection of Fossil Footprints of

Birds and Quadrupeds, and the Impressions of Fishes, from the new red sandstone of the Connecticut River. The collection of Minerals embraces an immense number of Crystals of Beryl, some of vast size, from the celebrated locality of Acworth, N. H. Particulars will be sent upon application to the subscriber. Among the specimens of this collection are the following, appraised by President Hitchcock, and Dr. Deane :

Ornithichnites.—No. 92. A Slab, 10×6 feet, literally covered with Footprints of Birds, at least 70 distinct impressions, arranged in determinate lines or transits. In two of these transits the Footstep is 10 inches in length, and the stride 3 feet and 8 inches. The surface is very bright and smooth, and the impressions are without blemish, showing in the most distinct manner the phalangeal, tarsal, and ungual depressions of the foot. Appraised at $350.

No. 93. Is the counterpart or cast of the foregoing, very fine. Appraised at $150.

No. 94. A slab in two pieces, about 8×4 feet in dimensions, from the same stratum as No. 92. 17 fine impressions, Appraised at $75.

No. 96. About 5×3 feet. 9 rows of tracks on its superior surface, and several in relief on its inferior. The impressions are very fine. The specimen is mounted to take a revolving motion. Appraised at $150.

No. 95. About 7×4. Literally covered with perfect impressions, at least 40 in all, arranged in determinate lines. Appraised at $75.

No. 97. Two Colossal Footprints, each 16 inches in length; stride 3 feet 6 inches. Very fine. Appraised at $25.

No. 100. Two Colossal Footprints, each 14 inches long; stride 3 feet 4 inches. Appraised at $25.

No. 99. A slab 6 feet 4 inches in length. One row of consecutive footprints, and others, very fine. Appraised at $30.

No. 98. Slab 7 feet 6 inches long. Footprints and Raindrops in relief. Appraised at $20.

No. 101. Four splendid impressions. Appraised at $20.

No. 102. Six imprints. Appraised at $10.

No. 103. A single Colossal Footprint, 18 inches in length. Appraised at $25.

Besides the foregoing, are a very great number of specimens, 100 of which are enumerated, appraised from $10 to $1. They are mostly from the celebrated localities of Turner's Falls, and South Hadley Falls, and embrace a large number of species; and the individual impressions are all so perfect as to display the anatomical configurations and phalangeal markings of the foot. It is a magnificent collection. These specimens will be sold singly, or in lots, as may be desired, to the highest bidder, starting from the appraised value.

Quadrupedal Footprints.—The Footprints of Quadrupeds are quite rare in the Sandstone Formation, yet they are very interesting. The collection embraces all the known species, and the specimens are truly beautiful. They indicate animals of diminutive size, probably of the Batrachian order of Reptiles, or the Tailed or Salamandrian species. The slabs containing these footprints are small, and are appraised from $10 downward.

Ichthyolites, or Fossil Fishes.—The collection of American Fossil Fishes is very extensive, and is derived from the localities of Sunderland, Mass., Middletown, Conn., and Pompton, N. J., and embraces eight or ten species of the Genera Paleoniscus and Catopterus. The specimens enumerated, amounting to 200, are entire and remarkably fine, and are appraised at $25, $20, $15, $10, $5, down to $1. Taken altogether, this collection offers a rare opportunity for acquiring these elegant fossils, which are otherwise so difficult to obtain, especially in a sound condition.

Minerals.—The collection of Beryls from Acworth, N. H., is large, and was obtained by Mr. Marsh, as were the foregoing fossils, by his personal exertions, and at great expense. It is very valuable, and was appraised by Prof. C. U. Shepard and Dr. Edward Hitchcock, and among the principal specimens are the following:

No. 240.	11	in.	diam.	38	in.	circum.	12	in. length.	Apprais'd at $20.
No. 235.	8	"	"	26	"	"	24	" "	" $15.
No. 234.	7½	"	"	24	"	"	9	" "	" $10.
No. 239.	9	"	"	32	"	"	19	" "	" $10.
No. 237.	9	"	"	29	"	"	14	" "	" $3.
No. 253.	15	"	"	39	"	"	16	" "	" $15.
No. 255.	12	"	"	40	"	"	10	" "	" $4.
No. 251.	8	"	"	28	"	"	13	" "	" $4.
No. 265.	13	"	"		"	"	12	" "	" $6.
No. 274.	9	"	"	30	"	"	22	" "	" $7.
No. 279.	12	"	"	38	"	"	13	" "	" $8.

Besides many others at $10, $8, $5, $3, $1, of which more than 100 specimens are enumerated. They are also arranged into suites, and will supply very desirable collections for mineralogists.

There are other choice minerals; among them are various specimens of Fossil Woods; of Dog Tooth Spar; of Fluor Spar; Galena; Barytes; Hematite; Specular Iron Ore; Calcite; Celestine; Troostite; Malachite; Tremolite; Lead and Silver ores; Tin Ore. A large number of Quartz Crystals, some containing water and other objects, and a great number of other specimens, Geodes, Septaria, Rain Drops, &c.

Miscellaneous Objects—Illustrating Aboriginal Arts. 225 specimens Indian Relics, found in the Valley of Connecticut River.

Eleven pieces Pottery and Discoidal Stones from the Mounds of Mississippi, very interesting. Stuffed Birds, Alligator, Boa Skins, Roman Lamp, Ancient Mosaic, English Minerals and Fossils, Limestone and Chalk Fossils, Coal Fossils, Mastodon remains, Fossil Corals, Show Cases, &c.

Coins.—1118 Pieces Copper Coins, including duplicates. 85 very rare Coins and Medals.

Shells.—A valuable collection of Shells and Corals.

Valuable Books.—17 Quarto Volumes Geological Survey of New York, Owen's Geological Survey, Hitchcock's Geology of Massachusetts, &c.

☞ The sale will be continued from day to day until it is completed, and it will probably afford the only opportunity that will occur for a long time, if ever, of acquiring the beautiful fossils of Connecticut River.

They can only be obtained by skillful prospecting at great risk and expense. All the localities have been exhausted for several years, and the only source from which they can now possibly be obtained is this extraordinary cabinet. The collection of these fossils is so extensive that several complete suites can be formed from it; for beauty, extent, and interest, it far surpasses any other collection ever made, in fact, all other collections combined ever made. L. MERRIAM, *Administrator.*

Greenfield, Mass., July, 1853.

V. BIBLIOGRAPHY.

1. *Miscellaneous Chemical Researches*: Inaugural dissertation for the degree of Doctor of Philosophy, addressed to the Philosophical Faculty of the University of Göttingen, by CHARLES A. JOY, of Boston. Göttingen, 1853. 50 pp. 8vo.—The researches here published were made part in Göttingen, under Prof. Wöhler, and part in Berlin, under Prof. H. Rose. They relate to the composition of shells, corals, meteoric iron, volcanic rocks, minerals, and some organic compounds. We defer to another number a further notice of the results.

2. *Report on certain points in the Geology of Massachusetts*; by Pres. EDWARD HITCHCOCK. Exec. Dep't Mass.; House Doc. No. 39. —This valuable report treats of (1.) the Coal Field of Bristol county and of Rhode Island; (2.) the Determination of the geological age and position of the beds of Brown Hematite Iron Ore in Berkshire county, Mass.; (3.) Marks of ancient Glaciers in Massachusetts. The second section has already appeared in this Journal; the others we propose to cite from at length in our next.

3. *Physical Geography*; by MARY SOMERVILLE, author of the connection of the "Physical Sciences," Mechanism of the Heavens, etc. A new American, from the 3d and revised London edition; with notes and a glossary, by W. S. W. RUSCHENBERGER, M.D., U. S. Navy. 570 pp. 12mo. Philadelphia, 1853. Blanchard and Lea.—The Physical Geography of Mrs. Somerville, the most learned woman of the age, is already well known. The whole range of the earth's physical features, both inorganic and organic, superficial, subterranean, and atmospheric, comes under discussion, beginning with a brief review of the principles of Geological Science, and closing with the races of mankind, their arts and civilization. This edition is somewhat enlarged through contributions to the work, by Dr. Ruschenberger, the American editor.

4. *Catalogue of the Oological Collection in the Academy of Natural Sciences of Philadelphia*; by A. L. HEERMANN, M.D., March 1, 1853.—This catalogue of birds' eggs embraces 1323 determined species of 493 genera. Of these, 835 species, derived from all parts of the world, formed the celebrated and valuable collection of Mons. O. Des Murs, of Paris. The Australian species, numbering 246, accompanied the splendid collection of birds from that country, made by the distinguished ornithologist Mr. John Gould, of London, and which is now in the Museum of the Academy. The Cuba species belonged to the collection of the well known naturalist M. Ramon de la Sagra, and were presented by Mr. E. Wilson.

The whole of the first two collections were purchased by Dr. T. B. Wilson, and, with his usual liberality, presented to the Academy. The remainder consists of species presented by several individuals whose names are attached to their donations throughout the catalogue. Of undetermined eggs in the collections of M. Des Murs and Mr. Gould, there are 197 species.

5. *Rural Essays;* by A. J. Downing, edited, with a memoir of the author, by George William Curtis, and a letter to his friends by Frederika Bremer. G. P. Putnam and Co.: New York, 1853. 558 pp. 8vo.—The Rural Essays here issued originally appeared as editorials in the Horticulturist. We are gratified to see them collected together under the elegant form now given them by Putnam. No one has done more by his writings or taste for American Landscape Gardening and Horticulture than Mr. Downing, and his death was one of the great calamities of the last year. The memoir of Mr. Downing by Mr. Curtis is full of interest, and forms a most appropriate introduction to the volume.

6. *Sixty-Sixth Annual Report of the Regents of the University of the State of New York.* 316 pp. 8vo. Albany, 1853.—Following the details relating to the public schools of New York, this Report contains several valuable Meteorological Tables; Observations on the Weather, Auroras, Level of the Lakes, Productiveness, etc., of 1852, Flowering of Plants, &c., by Rev. Chester Dewey; Table of the Periods when the Hudson River opened and closed at Albany; Tables of the Fall of Rain in the State; on the Periods of Cold Weather during the last few years, and the connection of Earthquakes with Atmospheric Changes, by E. Merriam.

7. *Illustrated Record of the Industry of all Nations;* Nos. 1, 2, 3, 4. Edited by B. Silliman, Jr. New York: G. P. Putnam and Co. Double Numbers of 18 pp. 4to, 25 cents.—This Illustrated Record, is as the name implies, a descriptive record of the objects of interest exhibited at the Crystal Palace, illustrated by engravings. The engravings are in wood, and are handsomely executed. The numbers in 4to, are printed in the best style, on a press at the Crystal Palace itself. The elegance of this publication, its cheapness, and its intrinsic value will insure it a wide distribution over the land. The display at the Palace is full of attractions in all the departments of the arts. It is inferior in extent to the Exhibition at London, but it should be observed, that while the one was the work of the British Empire, with the wealth of the nation at command, and enjoyed from the first the full confidence of the civilized world, near the centre of which it was placed, the other is in fact a private enterprise, in the western hemisphere, honored by the Government only after its completion, and till recently gaining but slowly the confidence of the people among whom it has been erected.

8. *The Mining Magazine.* No. II. August, 1853. Edited by Wm. J. Tenney, New York City, 142 Fulton St.—A good mining Journal, which should be a faithful and impartial record of mines and mining, would have a wide circulation through the land, where now there is an increasing interest in the mineral resources of this and other countries. The magazine before us, if ably conducted, would meet this want. We judge however, from the paper on the mines and mineral resources

of America, (No. II,) that more care will be needed in the preparation of papers, before it will reach the standard it should assume. In mentioning the mineral productions of New York, distinction is seldom made between good and bad localities, and an erroneous idea is conveyed of the productiveness of the State in metals. The artificial oxyd of zinc of the New Jersey furnaces correctly described in this Journal by Dr. Torrey, as early as 1822, (vol. v,) and more recently by Mr. Blake, the past year, (vol. xiii, 2nd. Ser., 417,) is spoken of first as the ancramitic oxyd of zinc, and afterwards under the old incorrect name of *Cadmia*, which is attributed to Prof. Silliman. The name ancramite was given it when it was first noticed, but has long since dropped out of use. Certain New York localities of zinc ore are stated to yield sulphate of zinc, *chromate* and carbonate. The precious stones of New York mentioned are, jasper, agate, garnets, *emerald*. The article on the Mines and Mineral Resources of America, (No. II,) thus leads the reader to believe that many things occur in the state of New York which do not, and that many localities afford workable beds, where there are mere traces of ore.

9. *Memphis Medical Recorder*, published bi-monthly by the Memphis Medical College. Edited by A. P. MERRILL, M.D., Prof. Mat. Med. and Therap., and C. T. QUINTARD, M.D., Prof. Phys. and Path. Anat. 48 pp. 8vo. Memphis. Vol. ii, No. 1, July, 1853. $1 per annum.—The western medical journals have a special value in the knowledge they are able to give of the diseases of the Mississippi Valley, and of the uses of medicines in their treatment. We understand that Prof. J. Millington is to be connected with the Memphis Medical College, and will contribute to the Memphis Medical Recorder. The present number contains as original papers, one on the uses of Veratrum viride, by H. V. Wooten, M.D., another on the relations of uterine and constitutional disorders as cause and effect, by L. Shanks, M.D.

10. *Annals of Science*, conducted by HAMILTON L. SMITH, A.M. Cleveland. The number of this semi-monthly for April 1, contains an important paper on fossil plants from Ohio, by J. W. FOSTER, illustrated by wood-cuts; and the numbers for February, March, April 15 and May, others on the same subject, by J. S. NEWBERRY.

11. *Report of the Superintendent of the Census for December*, 1852, *to which is appended the Report of December* 1, 1853. Printed by order of the House of Representatives of the United States. Washington, 1853.

12. Transactions of the Meteorological Society of Mauritius. 1853. No. 1, 8vo. 124 pp.

13. *Annals of the Lyceum of Natural History of New York, May*, 1853. Vol. vi, No. 1.—(1.) Descriptions of new species of birds of the genera *Ortyx*, Stephens, *Sterna*, Lin., *Icteria*, Vieillot, by G. N. LAWRENCE.—p. 1.

(2.) Additions to North American Ornithology, No. 3, by G. N. LAWRENCE.—p. 4, No. 2.

(3.) Ornithological Notes, by G. N. LAWRENCE.—p. 7.

(4.) Descriptions of new species of Helicidæ, by J. H. REDFIELD. —p. 14.

(5.) Descriptions of new species of Achatinella, from the Sandwich Islands, by Dr. W. NEWCOMB.—p. 18.

(6.) Note to the Description of Selene argentea of Lacepede, in vol. v of the Annals, by J. C. BREVOORT.—p. 30.

(7.) Observations on the animal of *Rotella*, Lam., by Rev. S. C. **FAIRBANK, of Bombay.—p. 35.**

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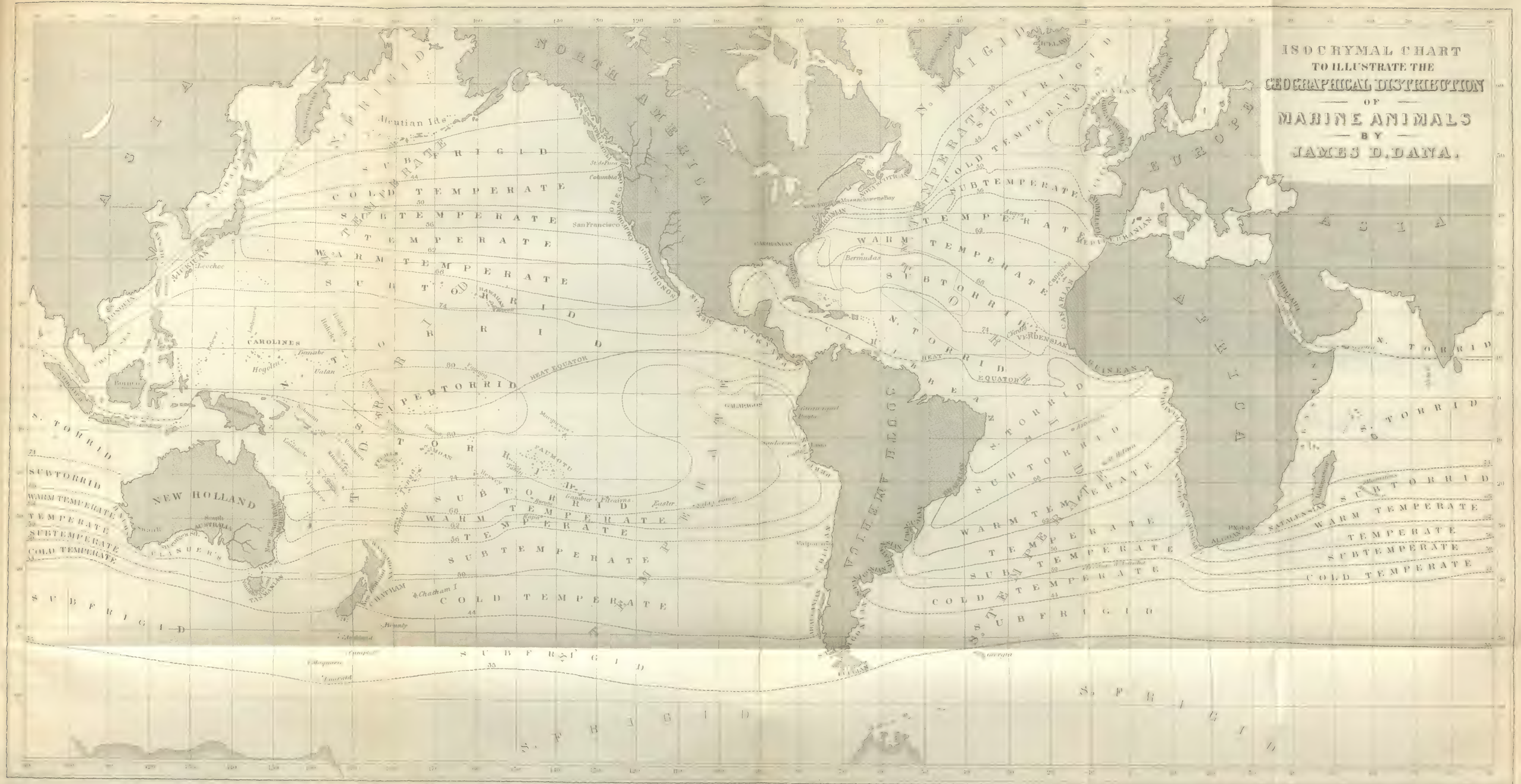
ISOCRYMAL CHART
TO ILLUSTRATE THE
GEOGRAPHICAL DISTRIBUTION
OF
MARINE ANIMALS
BY
JAMES D. DANA.
N. FRIGID
N. SUBFRIGID
N. TEMPERATE
N. SUBTEMPERATE
N. TEMPERATE
N. SUBTORRID
N. TORRID
EQUATOR
S. TORRID
S. SUBTORRID
S. TEMPERATE
S. SUBTEMPERATE
S. FRIGID
S. SUBFRIGID
ASIA
AFRICA
EUROPE
NORTH AMERICA
SOUTH AMERICA
NEW HOLLAND
HEAT EQUATOR
COLD TEMPERATE
SUBTEMPERATE
WARM TEMPERATE
SUBTORRID
TORRID
Aleutian Is.
San Francisco
Bermudas
CAROLINES
Hawaii
Tahiti
Galapagos
Chatham I.
Campbell
Auckland
Macquarie
Emerald
Valparaiso
Sandwich
Kerguelen
Amsterdam
Crozet
Prince Edward
Marion
Heard
Mauritius
Seychelles
Comoro
Madagascar
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Amirantes
Maldives
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Ceylon
Andamans
Nicobars
Sumatra
Java
Borneo
Celebes
Timor
Banda
Ternate
Gilolo
Ladrones
Philippines
Formosa
Loochoo
Japan
Kurile
Kamtschatka
Behring's Str.
Behring's I.
Aleutian Is.
Sitka
Columbia
Oregon
Monterey
Mexico
Sandwich Is.
Marquesas
Society
Low Archipelago
Pitcairn
Easter
Galapagos
Peru
Chili
Patagonia
Falkland Is.
Tierra del Fuego
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Terra del Fuego
Magellan Str.
Juan Fernandez
Tristan d'Acunha
St. Helena
Ascension
Fernando Noronha
Trinidad
Brazil
Abrolhos
Rio Janeiro
Buenos Ayres
Rio Plata
Cape Corrientes
Cape Frio
Cape Horn
Cape of Good Hope
Cape Agulhas
Cape Lagullas
Cape Verd Is.
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Madeira
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Bermudas
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Caribbee Is.
Barbadoes
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Venezuela
Columbia
Panama
Mexico
Gulf of Mexico
Florida
Carolina
Virginia
Massachusetts Bay
Newfoundland
Greenland
Iceland
Spitzbergen
Nova Zembla
Lapland
Norway
Sweden
Russia
Finland
Baltic
Denmark
Scotland
England
Ireland
France
Spain
Portugal
Italy
Sicily
Malta
Greece
Turkey
Black Sea
Caspian
Persia
Arabia
Red Sea
Abyssinia
Nubia
Egypt
Barbary
Algiers
Tripoli
Tunis
Morocco
Guinea
Senegambia
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Liberia
Ivory Coast
Gold Coast
Benin
Biafra
Congo
Angola
Benguela
Hottentots
Kaffraria
Natal
Mozambique
Zanzibar
Somauli
Mocha
Persian Gulf
Hindostan
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Burmah
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Morocco
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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XXX.—*Biography of Berzelius;* by Prof. H. Rose, of Berlin.

(Continued from p. 186.)

Sometime after the appearance of the mineral system, Berzelius published his work "*Ueber die Anwendung des Löthrohrs in der Chemie und Mineralogie.*" In Fahlun, under the guidance of his older friend Gahn, a pupil of Torbern Bergmann, he had acquired uncommon dexterity in the use of the blowpipe; and he had thus enriched this special part of chemistry with a number of original investigations, and brought it to a high degree of perfection. In the above-mentioned work he makes known everything connected with the subject, both what he had learned from Gahn and what he had himself discovered.

Rarely has a work been welcomed by chemists like this; indeed, so immediate a recognition of the practical value of a work is seldom possible. It was at once translated into most European languages; and in some, especially the German, it passed through several editions. Everywhere it met with merited appreciation; and Mr. Children alone, the editor of the English edition, allowed himself to add remarks as superfluous as they were ill-natured.

Besides the behavior before the blowpipe of the most important chemical compounds, all metallic oxyds, acids, and their salts, sulphurets, &c., Berzelius described the reaction of all minerals which he could obtain, and which were so much the more readily placed at his disposal, as he required only very small quantities for these experiments. He entered upon this investi-

gation with untiring industry, and was thus able to furnish even those mineralogists who but unwillingly admitted the influence of chemistry upon mineralogy, with an extremely welcome gift, since, by simple blowpipe experiments, it was made possible to distinguish minerals with ease and certainty, especially siliceous compounds, which were with difficulty, or only ambiguously, recognizable by means of their external characters.

This work bore so manifestly the stamp of perfection, even on its first appearance, that, with the exception of Plattner, in Freiberg, no one has contributed any essential additions or improvements to blowpipe investigations; and it is quite as indispensable to the chemist and mineralogist at the present day as it was thirty years ago.

About this time, Berzelius discovered selenium, and was engaged upon his admirable investigation of this element. Never was there an examination so accurate and thoroughly exhaustive, of an interesting and hitherto unknown element, comprising all its characters and remarkable combinations, so that, if we except the discovery of selenic acid by Mitscherlich, which escaped Berzelius, nothing essentially new was added to our knowledge of this element during the next thirty years. Our astonishment at this will be the greater when it is recollected that all these investigations were carried on with a very small quantity, only about an ounce of selenium, of which a part was lost through the carelessness of a servant.

This paper upon selenium can be compared only with that by Gay-Lussac upon iodine, which appeared several years before, and has yielded, in so many respects, such valuable results. It must, nevertheless, be remarked, that Gay-Lussac was not the discoverer of iodine, and did not undertake the investigation until after the first chemist of that time, Davy, had almost established the true nature of iodine; and that he had large quantities of materials at his disposal.

Almost at the same time that Berzelius was engaged in the examination of the compounds of selenium, Arfvedson was engaged in his laboratory with the analysis of some Swedish minerals; and under the guidance of Berzelius, succeeded in discovering lithium, which, as it came so unexpectedly, justly created great interest.

The following larger papers of Berzelius form, as it were, a series of monographs upon separate and important branches of chemistry, which were at that time still obscure. It was natural, when he commenced the demonstration of the law of definite proportions by means of a succession of laborious investigations, that he should throw aside much, in order to sketch the groundwork of his system. The investigations which he now undertook, were all instituted in accordance with a matured plan, and he had long meditated upon them before actually undertaking them.

The first of these researches was upon the ferruginous cyanogen compounds. Gay-Lussac, in his very important paper upon cyanogen, had neglected to study these compounds. After him, several chemists had occupied themselves with their examination, but all obtained very different results, the greater number, however, assuming that the iron in the so-called ferro-prussic acid salts was an essential constituent of the acid, which was combined in the salts with an oxydized body.

Berzelius. however, shewed that these salts contained neither prussic acid nor oxydized bases, but that they consisted of cyanid of iron combined with the cyanid of an alkaline metal, and consequently were double cyanids. He also extended his investigations to the salts of the so-called sulpho-cyanic acid, and shewed that they consist of a metal, sulphur, and cyanogen, the latter two united to form a radical (which he subsequently called Rhodan); and that in them likewise there was neither prussic acid nor oxydized bases.

These investigations, which fully confirmed the views of Gay-Lussac regarding cyanogen, were, however, of still greater importance to Berzelius in another respect. After Davy had been induced, by his researches in 1810, to consider that it was simpler and more correct to look upon chlorine as elementary. and not, as he had formerly done, as a compound of oxygen with a radical that had not been isolated; most chemists concurred with him in this view. Gay-Lussac and Thénard, who, even before Davy, considered a similar view possibly correct, although not exactly more probable than the old one, after the discovery of iodine, openly declared themselves, with Vauquelin and all the other French chemists, in favor of the new doctrine; and the famous paper of Gay-Lussac upon iodine, which appeared in 1813, is written in this spirit.

Berzelius alone, who from the first had disputed the hypothesis of Davy, continued to defend the old doctrine, even after the discovery of iodine. He did this especially in a paper which first appeared in Gilbert's Annalen for 1815. He there endeavored, with a profound sagacity which must be highly admired by every one, on reading the paper even after the lapse of so long a time, to prove the truth of the doctrine of the compound nature of chlorine. He directed attention to the remarkable phenomenon that the constituents of chlorid of nitrogen, which are united only by a very feeble affinity, separate with such an energetic evolution of heat as is never observed except in chemical combinations. But above all he pointed out the analogy which existed between muriates, which, according to the new theory, in the anhydrous state contain no oxygen, and the sulphates, phosphates, and other salts, which are indisputably compounds of oxygen acids with oxygen bases, and in which the presence of oxygen may be readily detected.

The great authority of Berzelius, and the soundness with which he carried out his refutation of all the evidence brought forward in favor of the new theory, were the reasons why many chemists, especially in Germany, did not adopt Davy's view of the nature of chlorine.

The immediate cause that led Berzelius to undertake the investigation of the cyanids of iron was evident, viz., he expected to find in them a more complex radical (united with oxygen forming an acid) associated with an oxygen base, and similar to that which he assumed to exist in muriates. It cannot be disputed that to some extent he doubted the accuracy of Gay-Lussac's experiments on cyanogen. Then, as the salts of the ferrocyanic radicals resemble so closely in their characters the ordinary oxygenous salts, and especially as several metallic cyanids, such as cyanid of mercury or silver, correspond so completely with the analogous chlorine compounds, he was of opinion that if he could by this investigation detect oxygen in the ferrocyanic compounds, it would be a strong proof of its presence in muriates likewise, and, consequently, evidence in favor of the old theory of the nature of chlorine.

However, the result of these investigations was the opposite of that which he expected, and thus the main argument against the new doctrine of the nature of chlorine fell to the ground. When other reasons for the greater probability of the new theory were from time to time discovered, Berzelius adopted it with the most amiable candor, and relinquished the old theory which he had so long and so ably defended.

One, among the reasons was, as I know, the following:— Immediately after Berzelius's investigations on the cyanids of iron, Leopold Gmelin obtained the interesting red double salt of cyanid of potassium and cyanid of iron, which is anhydrous and contains no oxygen. The red color of peroxyd of iron, which is more or less communicated to all its salts except the neutral ones, was to Berzelius an additional reason for regarding the red perchlorid of iron as an actual salt with an oxygenous base; and, as in the salt obtained by Gmelin, notwithstanding its red color, the iron was not in the state of oxyd, but directly combined with cyanogen, (one double atom of iron with three double atoms of cyanogen,) Berzelius saw that it was probable that the red color of iron compounds was not owing alone to the presence in them of peroxyd, but was also common to those in which one double atom of iron is combined with three double atoms of chlorine or cyanogen.

Another main inducement to adopt the new theory of the nature of chlorine, consisted in the results which he derived in favor of it from his subsequent comprehensive researches upon alkaline sulphurets. According to Berthollet's investigations, these

bodies were regarded as combinations of sulphur with alkalies until Vauquelin put forward the opinion, that when a fixed alkali was melted with sulphur, a part of the alkali was reduced to the metallic state, sulphuric acid was formed, and a mixture of alkaline sulphate and sulphuretted metal was obtained. This which Vauquelin was able to put forward only conjecturally, and could not demonstrate by convincing proofs, was immediately proved most satisfactorily by Berzelius through his successful reduction of sulphate of potash by means of hydrogen or the vapor of the sulphuret of carbon. He thus obtained sulphuret of potassium in which there could not be any oxygen. By treating anhydrous lime with sulphuretted hydrogen at a high temperature, Berzelius likewise obtained water and sulphuret of calcium. This experiment rendered it obvious that when liver of sulphur is obtained by melting together sulphur and carbonate of potash, the solution in water contains sulphuric acid, which is not, as Berthollet conjectured, first formed by the decomposition of water, but is a joint product with the liver of sulphur of the reduction of the alkali. Berzelius found, moreover, that the alkaline metals combine in several definite proportions with sulphur forming substances which are all soluble in water. Thus arose the question: What is contained in such a solution?—a question, the answer to which is especially important when regarded in connection with the solutions of metallic chlorids. Is this liquid a solution of the unaltered sulphuret in water, or is the alkaline metal oxydized, and, consequently, a compound of sulphuretted hydrogen with alkali formed, or a compound of sulphuretted hydrogen, sulphur, and alkali? Since, in the last case, it would be necessary to assume as many compounds of sulphur with hydrogen as there are compounds of sulphur with the alkaline metals, Berzelius decided in favor of the second view. Subsequent investigations of the solution of sulphur compounds of the metals of alkaline earths in water, have, in fact, shewn that a decomposition of water really does take place in this case, and that a compound of metallic sulphuret with sulphuretted hydrogen and alkaline oxyd is formed.

Berzelius regarded these investigations as proving that sulphur compounds exist which are very analogous to the muriates, and that there might likewise be bodies which, without containing an acid and an oxygenous base, possess, like the chlorids, all the peculiar characters of salts; and, consequently, if this were so, all that evidence against the new theory of chlorine failed, which he had derived from the perfect analogy of muriates with salts consisting of an oxygen acid and an oxygenous base.

With this investigation on alkaline sulphurets was connected the equally important one upon the sulphur salts, which, however, did not appear until several years afterwards.

In the former paper Berzelius had directed attention to the fact, that the sulphur compounds of alkaline and earthy metals combine with other metallic sulphurets in the same way as the oxyds of these metals combine with other oxyds. Double sulphurets are thus formed which admit of being compared with ordinary salts, inasmuch as one metallic sulphuret constitutes the electro-positive, that is, the basic part of the compound; the other, on the contrary, the electro-negative part, representing the acid. But here only the lowest sulphurets of the alkaline metals, that is, those corresponding as regards their composition with the basic oxyds of these radicals, will fill the place of basic sulphurets; the higher sulphurets behave, as it were, like peroxyds; they may sulphurize other metals, but do not combine with their sulphur compounds.

The different sulphur compounds of the electro-negative metals which Berzelius called sulphids, and whose composition is analogous to that of the metallic acids, combine with the electro-positive or basic sulphurets in such proportions, that if the sulphur were replaced by an equal number of atoms of oxygen, some one of the salts would be formed which the same radicals would yield in their oxydized state.

Of the sulphur compounds of the non-metallic elements, those of carbon and hydrogen alone combine with the basic sulphurets of the metals; the latter class of compounds,—those of sulphuretted hydrogen with alkaline sulphurets,—were already known under the name of hydrothio-alkalies, but their true composition was not recognized until now.

Berzelius regarded this extensive series of sulphur compounds appropriately as salts, and gave them the suitable name of sulphur salts, in order to distinguish them from the oxygen salts, or those which had been long known, and the so-called haloid salts, under which name Berzelius comprised the compounds of chlorine, bromine, iodine, fluorine, and cyanogen, as well as other compound radicals with metals.

This discovery of sulphur salts, is indisputably one of the most important extensions of chemistry. Berzelius entered upon their study with great industry, and the number of sulphur salts examined by him amounted to about 120, to many of which he certainly could give only a passing attention, although he analyzed many quantitatively.

Next to this followed his investigation of hydrofluoric acid, one of the most important which Berzelius executed, since it has thrown such an unexpected light upon several of the most interesting departments of chemistry.

Thénard and Gay-Lussac had indeed already prepared hydrofluoric acid in a pure state, and several of its compounds. But as they were at the same time occupied with a number of other im-

portant researches, they did not pursue this subject further, and especially did not study with sufficient accuracy the phenomena which presented themselves when potassium was heated in fluorid of silicium.

Berzelius, in the first instance, prepared the most important metallic fluorids; then he went on to the remarkable compounds which hydrofluoric acid forms with electro-negative fluorids, especially fluorid of silicium, and fluorid of boron, besides fluorid of titanium and others. It was through him that we first acquired a correct conception of the composition of hydrofluosilicic acid and the fluosilicates, as well as of the action of water upon fluorid of silicium. But the most productive part of this investigation was when Berzelius repeated the experiments of Gay-Lussac and Thénard, for the purpose of decomposing fluorid of silicium by means of potassium. He had just at this time learned from Wöhler how to prepare potassium by means of carbonate of potash and carbon according to Brunner's method, and thus provided himself with large quantities of this metal. On decomposing fluorid of silicium by potassium he obtained the same results as the French chemists: namely, the brown non-metallic substance which they regarded as a complex compound of fluosilicid of potassium and of fluorid of potassium with silica. Berzelius found that it was impure silicium, which, when washed with water, could be obtained free from all fluorine compounds. It then contained only an admixture of silica, which could be extracted by concentrated hydrofluoric acid, after having previously been slowly heated to redness. He moreover shewed that the silicium could be obtained in different states of density, and with different characters.

This unexpected result induced him to undertake similar investigations with fluorid of boron. We are indebted to him for a correct knowledge of the decomposition of fluorid of boron by water, and of the composition of fluoborids, as well as an easy method of preparing boron, by treating fluoborid of potassium with potassium. He likewise discovered at this time the gaseous chlorid of boron, and corrected the views of the composition of boracic acid by his own experiments and those of Arfvedson. He moreover prepared the compounds of fluorid of titanium with metallic fluorids, especially fluorid of potassium, from which body he shewed how metallic titanium was to be obtained by means of potassium. This is the only method by which titanium can be obtained in a pure state; for the experiments of Wöhler have proved that the substance found in the slags of iron furnaces, and formerly called metallic titanium, contains nitrogen and cyanogen. The compounds of fluorid of tantalum with metallic fluorids were also prepared, and he obtained metallic tantalum in the same way as titanium. He then reduced zirconium from the zirconio-fluorid

of potassium by means of potassium, studied the characters of zirconia, and finally turned his attention to the double compounds of fluorid of molybdenum and fluorid of tungsten with metallic fluorids, of which, however, he prepared only the compounds of fluorid of potassium with molybdate and tungstate of potash.

Berzelius had intended to pursue further these very interesting investigations of fluorine compounds. But when he found that a distinguished French chemist had also commenced the study of fluorine compounds, and had already named some newly discovered ones, he gave up this intention.

It must be remarked, that in these investigations Berzelius assumed, as he had previously done in the case of hydrochloric acid, that fluoric acid was an oxygen acid, and that it contained a radical, combined with two atoms of oxygen. But in the same year that he gave up the study of fluorine compounds, viz., in 1825, he observed in the first part of the third German edition of his "Lehrbuch," that it was more probable that fluoric acid, like hydrochloric acid, was a hydrogen acid; and he described all the fluorine compounds according to this view.

Together with these comprehensive researches, Berzelius published a number of less extensive ones. They all originated in his meeting with a number of doubtful statements while editing his "Lehrbuch," in reference to which he immediately instituted experiments in his laboratory, for the purpose of quickly deciding upon them. From among these I will here mention only the research upon chlorid of lime, which was formerly regarded, according to Gay-Lussac, as a compound of chlorine with lime, and the chlorids of potash and soda which were likewise regarded as similar in composition. Berzelius, on the contrary, directly after adopting the view of the elementary nature of chlorine, declared these bleaching compounds to be mixtures of metallic chlorids with salts, containing an oxyd of chlorine as an acid. He was of opinion, as he did not closely examine the subject, that the acid was chlorous acid, until the researches of Balard proved that it was hypochlorous acid.

Berzelius proved, that all the other explanations of the composition of the bleaching compounds were incorrect, by shewing that these contained an oxyd of chlorine. He dissolved in a solution of carbonate of potash, as much chlorid of potassium as it would take up, and passed chlorine through the liquid without saturating it. After a few minutes chlorid of potassium was precipitated, which contained no chlorate of potash, or scarcely any; the liquid had acquired the power of bleaching. When the liquid was separated from the precipitated chlorid of potassium, and perfectly saturated with chlorine, chlorate of potash was precipitated, containing scarcely any chlorid of potassium. Consequently, during the first action of the chlorine, chlorid of potassium must

have been formed from potash, the oxygen of which could have combined only with chlorine, giving rise to the production of the bleaching compound.

It had long been the wish of Berzelius to investigate the rare metals accompanying platinum, the knowledge of which had been left imperfect by the chemists who discovered them. He was enabled to carry this into execution, when, after the discovery of the large quantities of platinum in the Ural, he received through Herrn von Cancrin, a considerable quantity of native platinum, as well as native Osmium-Iridium. This circumstance led him into a very important investigation of the process for decomposing native platinum ores, by means of which the rare metals accompanying platinum were first properly made known. He studied the characters, determined the atomic weights of Rhodium, Palladium, Iridium, and Osmium, and prepared a number of their compounds. Owing to the great number of the oxyds and chlorids of these metals, and their great similarity to each other, this investigation was very difficult; and, as regarded osmium and osmic acid, a very unpleasant one. But although Berzelius himself declared that he had as it were given only the sketch of the history of these metals, still this research, like all that came from his hands, was an extremely accurate, and to a certain extent, perfect one.

The next investigation of Berzelius was in reference to a new and peculiar earth, Thoria, which he had discovered in a mineral from Brevig, in Norway. He had previously, on examining the minerals near Fahlun, found an earthy substance in very small quantity, which he regarded, although not with certainty, as a new earth, which he called Thoria; subsequently, however, he convinced himself that it was phosphate of Yttria. Since the newly discovered earth resembled, in some of its peculiar characters, alumina, he called this likewise Thoria; the mineral in which he had detected it, he named Thorite, and the metal which he obtained from its volatile chlorine compound, Thorium. Thoria belongs to a group of earths very similar in character to zirconia, several of which Svanberg, Bergemann, and Sjögren have recently discovered. At first Berzelius assumed that thoria contained only one atom of oxygen; the experiments, however, which he made for the purpose of determining the atomic weights of the metal and earth, are probably not quite decisive, and it is perhaps more likely that the earth is composed of two atoms of metal and three atoms of oxygen.

(*To be continued.*)

Art. XXXI.—*On an Isothermal Oceanic Chart, illustrating the Geographical Distribution of Marine animals;* by James D. Dana.

(Continued from p. 167.)

Remarks on the Several Temperature Regions.

The form and varying breadth of the different regions, and the relations between the sea-temperatures of coasts in different latitudes, which they exhibit, are points demanding special remark. The conclusions are of much interest, although some changes in the chart will undoubtedly be required by future researches.

Atlantic Torrid Region, between 74° F. *north, and* 74° F. *south.*—The form of this region is triangular, with the vertex of the triangle to the east. Its least width is four degrees of latitude; its greatest width between the extreme latitudes, is forty-six and a half degrees. On the African coast it includes only a part of the coast of Guinea, and no portion is south of the equator. On the west, it embraces all the West India Islands and reefs (excepting the Little Bahama,) and the South American coast, from Yucatan to Bahia,—a fact that accounts for the wide distribution of marine species on the American side of the ocean.

Atlantic Subtorrid Regions, between 74° *and* 68° F.—The *North Subtorrid Region* of the Atlantic is about six degrees in its average width, which is equivalent to a degree of Fahrenheit to each degree in surface. It encloses within the same temperature limits, a part of the east coast of Florida, between 24° and 27½° north, and a part of the African coast, between the parallels of 9° and 14½° north, the two related coasts differing ten degrees in latitude. The Bermudas, in latitude 33°, and the Cape Verdes, in 15½°, fall within this region.

The *South Subtorrid Region* has the same average width as the northern.

Taking the whole Atlantic Torrid or Coral-reef zone together, its width on the east is about twenty-one degrees, while on the west, it extends between the parallels of 30° south and 34° north, a breadth of sixty-four degrees. As many species will thrive under the temperature of any part of the Torrid zone, the geographical range of such species in the Atlantic may be very large, even from Florida and the Bermudas on the north, to Rio Janeiro on the south, a range of which there are actual examples.

Atlantic Warm Temperate Regions, between 68° *and* 62° F.—The *northern* of these regions has a breadth of fourteen and a half degrees along the west of Africa, and about seven degrees along the United States, to the south of Cape Hatteras, off the Carolinas, Georgia, and northern Florida. These shores and the Canaries are therefore in one and the same temperature zone.

The *southern* of these regions averages five degrees in width. The eastern limit on the African coast is sixteen to eighteen degrees to the north of the western on the South American coast.

Atlantic Temperate Regions, between 62° *and* 56° F.—The *north* Temperate Region is but a narrow strip of water on the west, terminating at Cape Hatteras, and having no place on the coast of the United States. To the east it widens, and embraces the Azores, and the African coast along Morocco, together with the Straits of Gibraltar, and a large part of the Mediterranean. Madeira lies upon its southern limit. It is, therefore, natural, that the same species should occur at the Azores. Madeira, and on the African coast, and be excluded wholly from the Atlantic coast of Europe. This according to Prof. Forbes, is the fact with the *Littorina striata*, besides other species. The coasts of Portugal and the Azores are in different regions.

The *South* Temperate Region extends to Maldonado at the mouth of the La Plata, from near the parallel of 30°; along the African coast it reaches over more than twice the number of degrees of latitude, to within five degrees of Cape Town.

Atlantic Subtemperate Regions, between 56° *and* 50° F.—The *northern* of these regions, like the preceding, can not be distinguished on the coast of the United States, as the lines of 50° and 56° F. with 62° fall together at Cape Hatteras. On the eastern side of the Atlantic, it occupies the coast of Portugal to latitude 42° north, having a width of five degrees. It thus corresponds on this coast to the so-called Lusitanian Region.

The *southern* includes the mouth of the La Plata on one side, and on the other the coast near Cape Town, beyond which it extends to the Cape of Good Hope or rather to Cape Lagulhas.

Atlantic Cold Temperate Regions, between 50° *and* 44° F.—The coast from Cape Cod to Cape Hatteras belongs to the *Northern* Cold Temperate Region. Passing easterly, this region is but a narrow line of water for thiry degrees of longitude, after which it expands, and finally terminates between Western Ireland and latitude 42° on the Spanish coast. The British Channel, the Bay of Biscay, and probably Vigo Bay, Spain, are within the limits of this region.

The *southern* embraces the coast of South America, along by Rio Negro for about five degrees, and passes wholly to the south of Africa.

Atlantic Subfrigid Regions, between 44° *and* 35° F.—The coast of Massachusetts, north of Cape Cod, of Maine and Newfoundland, and all Northern Britain, the Orkneys, Shetlands, and Faroe Islands, pertain to the *northern* Subfrigid Region; while the *southern*, includes the Falklands, Southern Patagonia, and Fuegia.

Atlantic Frigid Regions, beyond 35° F.—Greenland, Iceland, and Norway are within the *northern* of these regions, and the South Shetlands, Sandwich Land, and South Georgia, within the *southern.*

Pacific Regions.—A comparison of the regions of the Atlantic and Pacific, and especially of the limits of those commencing at the South American coasts, brings out some singular facts.

The *Torrid* region of the Pacific, near the American coast, embraces only seventeen and a half or eighteen degrees of latitude, all but one of which are north of the equator; while that of the Atlantic covers a long range of coast, and reaches to 15° south. The south *Subtorrid* Region has a breadth of about three degrees on the Peruvian coast, reaching to 4° south, or probably to Cape Blanco, while that of the Atlantic extends to Rio Janeiro, in 24° south. The *Warm Temperate* Region, if at all found north of Cape Blanco, $4\frac{3}{4}$° S., has a breadth of less than a degree, while that of the Atlantic extends to Rio Grande, in 33° south. The next or *Temperate* Region has a longer range on the South American coast, extending to Copiapo, in $27\frac{1}{2}$° south, and the Atlantic region corresponding goes to Maldonado in 35° south. The *Cold Temperate* Regions of the two oceans cover nearly the same latitudes.

On the North American coast at Cape Hatteras, the three isocrymes 62°, 56°, and 50° F., leave the coast together; and in the Pacific on the South American coast there is a similar *node* in the system of isocrymes, the three 74°, 68°, and 62°, proceeding nearly together from the vicinity of Cape Blanco.

Viewing these regions through the two oceans, instead of along the coasts, other peculiarities no less remarkable are brought out. The average breadth of the *South Torrid* Region in the Pacific, is more than twice as great as that of the same in the Atlantic; and the most southern limit of the latter is five degrees short of the limit of the former in mid-ocean. So also, the *Subtorrid* Region at its greatest elongation southward in the Atlantic, hardly extends beyond the mean course of the line of 68° F. in the Pacific, and the average breadth of the former is but two-thirds that of the latter. The same is true to an almost equal extent of the Warm Temperate and Temperate Regions.

The breadth of the Torrid Region of the Pacific to the eastward, where narrowest, is about six degrees; and to the westward, between its extreme limits, forty-nine degrees. The Torrid zone or Coral-reef Seas, in the same ocean, has a breadth near America, of about eighteen degrees, and near Australia and Asia, of sixty-six degrees.

New Zealand lies within the Subtemperate and Cold Temperate Regions, excepting its southern portion, which appears to pertain like Fuegia to the Subfrigid. Van Diemens Land, exclusive of its northern shores, is within the Cold Temperate.

Other particulars respecting the temperature regions through the Pacific will be gathered from the Chart.

Indian Ocean Regions.—The Torrid Region covers the larger part of the Indian Ocean, including all north of the equator, and embracing the larger part of Madagascar. The Subtorrid extends just beyond Port Natal on the African coast (four degrees of latitude north of Cape Town), where there are coral reefs, and also covers the northern part of the Red Sea. The Warm Temperate and Temperate regions each claim a part of the South African coast, and the latter terminates at Cape Lagulhas.

It hence follows that Port Natal, in latitude 30° south, the Hawaiian Islands, and Bermudas, lie within regions of the same name; while Cape Town, in latitude 34° south, is in a like region with northern New Zealand, Valparaiso, the Atlantic shores of Portugal, and the sea between Cape Hatteras and Cape Cod.

The areas of the Torrid, Temperate, and Frigid zones of ocean temperature, either side of the equator, considering 27° as the normal limit between the first two of these zones, and 56° the limit between the Frigid and Temperate, are as follows:—

Torrid zone,	33,711,200	square miles (geographical)
Temperate zone,	27,849,500	" " "
Frigid zone,	12,694,700	" " "

It is hence seen that the Temperate zone, although two degrees wider than the Torrid, has not as large a surface. The species of marine life, if distributed equally over the two, would, therefore, be one-fifth more numerous in the Torrid zone than in the Temperate, unless the extent of ocean and coast line were far greater in the Temperate than in the Torrid zone, which is not the case. The ocean in the southern Temperate is much more extensive than that of the southern Torrid; but the coast line is far less extensive in the former, as it does not abound in islands like the Torrid zone.* It is difficult to fix upon exact ratios and we do not attempt it.

* The following table gives very closely the surface of the zones in square geographical miles, for every 2½ degrees of latitude to the parallel of 60°: it is deduced from a larger table by Berghaus, in his Länder- und Volker-kunde, i. 47. The first is the zone from the equator to the parallel of 2½°, the second, from 2½° to 5°, and so on.

2½°	3,239,296	32½°	2,769,696
5°	3,232,800	35°	2,693,760
7½°	3,220,496	37½°	2,612,688
10°	3,202,048	40°	2,526,624
12½°	3,177,472	42½°	2,435,776
15°	3,146,912	45°	2,340,256
17½°	3,110,320	47½°	2,241,280
20°	3,067,808	50°	2,136,128
22½°	3,019,472	52½°	2,027,840
25°	2,962,176	55°	1,915,696
27½°	2,905,632	57½°	1,767,168
30°	2,840,368	60°	1,690,704

The zone from 60° to 70° has the area, 5,466,992
" 70° to 80° " " 3,350,064
" 80° to 90° " " 1,128,144

The range of temperature is far greater in the Temperate zone than in the Torrid, it being 20° F. in the latter, and 33° F. in the former; and this should be a cause of a greater variety of genera in the latter for the same number of species.

In the Torrid zone, the *Subtorrid* Region has nearly one-third the surface of the *Torrid* Region, and not one-fourth as much coast line, facts which should be regarded in comparing the number of species of the two.

We add here, a few brief remarks, in a popular way, on the origin of the peculiar forms and positions presented by the isothermal lines of the ocean. The great currents of the globe are admitted to be the causes that produce the flexures and modify the courses of these lines. These currents are usually of great depth, and consequently the deflecting land will be the deeply seated slopes off a coast, beyond ordinary soundings.

The *eastern* coasts of the continents either side of the equator, feel the influence of a warm equatorial current, which flows westward over each ocean, and is diverted north and south by the coasts against which it impinges, and more or less according to the direction of the coast.

The *western* coasts of the continents, on the contrary, receive a strong extra-tropical or polar current. In the southern oceans, it flows from the westward, or southward and westward, in latitudes 45° to 65° south, and is brought to the surface by the submarine lands or the submarine slopes of islands or continents: reaching the continents of Africa and South America, it follows along the western coasts towards the equator. The same current, being divided by the southern cape of America, flows also, with less volume up the eastern coast, either inside of the warmer tropical current, or else on both sides of it. In the Northern Seas, the system of polar currents is mainly the same, though less regular; their influence is felt on both eastern and western coasts, but more strongly on the *eastern*. In the Atlantic, the latter reduces the temperature of the waters three or four degrees along the north coast of South America, as far nearly as Cape St. Roque.

The cold currents are most apparent along the coasts of continents and about islands, because they are here brought to the surface, the submarine slopes lifting them upward, as they flow on. The limits of their influence towards the equator depends often on the bend of the coast; for a prominent cape or a bend in the outline will change the exposure of a coast from that favorable to the polar current to that favorable to the tropical, or the reverse. Thus it is at Cape Hatteras, on the coast of the United States; Cape Verde, on Western Africa; Cape Blanco, on western South America, etc.

These are important principles modifying the courses of the oceanic isothermal lines. We may now proceed to the application

of them which the best authors afford us, and to some conclusions flowing from the facts.

In the Atlantic, the warm tropical current flowing westward, is trended somewhat northward by the northern coast of South America, and still more so by the West India Islands, and thus it gradually curves around to parallelism with the coast of the United States. But south of Newfoundland, either wholly from the influence of the colder current with which it meets, or in part from meeting with submarine slopes that serve to deflect it, it passes eastward, and afterwards, where it is again free to expand, it spreads both eastward and north-eastward. The flexures in the isocrymes of 74° and 68° F., near the United States coast, thus have their origin. For the same reason, the line of 56° F. is nearly straight, till it reaches beyond the influence of the Newfoundland Banks, and then makes its Gulf Stream flexure. The line of 44° F. for the same reason,—the spreading of the Gulf Stream waters—diverges far from the equator in its easterly course, and even rises in a long loop between Great Britain and Iceland.

The cold currents flowing down the eastern coast of America, bend the isocrymes far south close along the coast, and make a remarkable southern flexure in the isocrymes of 68° F. outside of the Gulf Stream flexure. So on the western coast of Britain, the isocryme of 44° F. has a deep southern flexure, for a like cause.

The waters of the tropical current gradually cool down in their progress, through the influence of the colder waters which they encounter; and along the isocryme of 62°, they have in the colder seasons a common temperature with that of the ocean, so that the course of the Gulf Stream is but faintly marked in it. And also in the western half of the region covered by the isocryme of 56°, the colder and warmer waters have reached this as a mean temperature. Owing to the influence of the polar current on the northern coast of South America, the equator of heat lies at a distance from the land.

Up the western coast of Africa flows the cold current from the south and west, bending upward all the isocrymal lines; and passing north of the equator, it produces a large southern bend, off the coast of Africa, in the northern isocryme of 74° outside of the warm current flexure from the coast of Guinea, and also a large northern flexure in the heat-equator.*

The Atlantic tropical current also flows in part down the eastern coast of South America, giving a deep flexure to each of the isocrymes, besides making these lines to diverge from the equator, through all their length. Again, the polar current passes north-

* Along the ocean, near Africa, south and southeast of the Cape Verdes, Captain Wilkes found a current setting to the northward for much of the time until passing the equator.

ward nearer the coast-line, bending far back the western extremity of each of the isocrymes.

In the Pacific, the *tropical* currents show their effects near the coasts of New Holland and China, in a gradual divergence of the lines from the equator. The ranges of islands forming the Tarawan, Radack, and Ralick Groups, appear to divert the current northward in that part of the North Pacific, and consequently the isocrymal lines bend northward near longitudes 170° west and 180°; and near Niphon, that of 68° shows a still greater northern flexure.

The influence of the *extra-tropical* currents in this ocean is remarkably great. The southern flows from the west and south, bending upward the line of 56° F. along the South American coast, producing at Valparaiso at times a sea-temperature of 48° F. Still farther north, it throws the line of 68° F. even beyond the equator and the Gallapagos; and that of 74° F., nearly fifteen hundred miles from the coast, and four hundred north of the equator. The line of 62° F. reaches even beyond Payta, the sea-temperature at this place being sometimes below 61°.

The north polar current produces the same result along the eastern coast of Asia, as on the eastern of America. The isocryme of 74° F. is bent southward from the parallel of 23° to 12° 30′ north; and that of 68° F. from 34° to 15° north, and the latter deflection is even longer than the corresponding one in the Atlantic. The trend of the coast opens it to the continued action of this current until the bend in the outline of Cochin China, below which the cold waters have less influence, although *still showing some effect upon the heat-equator.* The isocryme of 44° is bent southward to Niphon, by the same cold waters, and from this part of the northern Pacific the current appears to flow mostly between the islands of Japan and the continent.

In the Indian Ocean, the effects of the tropical current, as it flows westward, are apparent in the southern deflection of the several isocrymes. The trend of the coast favors a continuation of the current directly along the coast, and consequently, its modifying influence on the sea-temperature reaches almost to Cape Town on the coast, and passes even beyond it at sea, carrying 56° F. to the meridian of 15° east.

By comparing the regions of the different oceans, north and south of the equator, we may arrive at the mean position of the several isocrymes, and thereby discover on a grander scale, the influence of the various oceanic movements.

For the purpose of reaching mean results, the Middle Pacific is the most favorable ocean for study. This is apparent in its greater extent, and the wide distance between the modifying continents; and also no less in the greater actual regularity of the isocrymes.

We thence deduce, that the mean position of the isocryme of 74° F. is along the parallel of 20°, this being the average between the means for the North and South Pacific. In the same manner we infer that the mean position of the isocryme of 68° F. is along the parallel of 27°.

The southern isocrymes of 56° and 62° F., are evidently thrown into abnormal proximity by the cold waters of the south. This current flows eastward over the position of the isocryme of 44° F., and consequently in that latitude has nearly this temperature, although colder to the south. Hence it produces little effect in deflecting the line of 44° F.; moreover, the line of 50° F. is not pushed upward by it. But the lines of 56° and 62° F. are thrown considerably to the north by its influence, and the Warm Temperate and Temperate Regions are made very narrow. With these facts in view, we judge from a comparison of the North and South Pacific lines, that the mean position for the isocryme of 62° F. is the parallel of 32°; and for 56° F., the parallel of 37°; for the isocryme of 50° F., the mean position is nearly the parallel of 42°; for 44° F., the parallel of 47°; for 35° F., the parallel of 56°. There is thus a mean difference of five degrees of latitude for six degrees of Fahrenheit, excepting near the equator and between 35° and 44° F. These results may be tabulated as follows.*

Isocryme of	80° F.,	Parallel of	6°
"	74°,	"	20°
"	68°,	"	27°
"	62°,	"	32°
"	56°,	"	37°
"	50°,	"	42°
"	44°,	"	47°
"	35°,	"	56°

Using these results as a key for comparison we at once perceive the great influence of the oceanic movements on climate and on the geographical distribution of marine life.

The polar or extra-tropical current of the Southern Atlantic has a more northward course in mid-ocean than that of the Pacific. It consequently bears up the isocryme of 35° F. to the parallel of 50°, that is, six degrees above the mean. The effect on the other isocrymes of the Atlantic is very remarkable. We perceive, in the first place, that the *most southern* point of each of these isocrymes is not far from the mean position of the same isocrymes in the Pacific, while the most northern point of each is ten to twenty-five degrees farther north. Taking the position of the isocrymes of 68°

* We may hence deduce the temperature of those isocrymes to which the parallels of latitude for every five degrees would normally correspond. They would be for 20°, 74° F.; for 25°, 70° F.; for 30°, 64·4° F.; for 35°, 58·4° F.; for 40°, 52·4° F.; for 45°, 46·4° F.; for 50°, 41° F.; for 55°, 36° F.; for 60°, 31° F.

and 74° F., where they cross the meridian of 15° west, as the mean position for this ocean, we find that the former is eight degrees in latitude farther north than 68° F. in the South Pacific; and the mean for the latter is in 7° south, while for the same in the Pacific it is 20° south, making a difference of thirteen degrees. The effect of the cold southern waters is consequently not along the African coast alone, but pervades the whole ocean. It is hence obvious, how utterly untenable the common notion, that the tropical current from the Indian Ocean is the same which flows up the west African coast. With a temperature of 56° south of Cape Town, it would be wholly incapable of causing the great deflections for the whole South Atlantic which have been pointed out. It combines with the cold current, but does not constitute it. The facts thus sustain the opinions long since brought forward by the distinguished meteorologist Mr. Wm. C. Redfield, that the currents flowing north along the African and South American coasts are alike antarctic or cold temperate currents.*

We may now turn to the North Atlantic. In this part of the ocean, the mean positions of the isocrymes of 74° and 68° F., are near the normal positions deduced from the Pacific. The line of 62° F. is in a somewhat higher latitude, the mean position, excluding the eastern and western deflections, being near the parallel of 36°. The line of 56° F. has the parallel of 42½° north for its mean position over the middle of the ocean, which is five and a half degrees above the normal in the Pacific. The line of 50° has in the same manner for its mean position over mid-ocean, the parallel of 47½°, or again five and a half degrees above the normal position in the Pacific. The line of 44° F. may be considered as having for its mean position the parallel of 52° north, while it rises to 60° north. The lines in the North Atlantic above that of 68°, average about five degrees higher in latitude than the mean normal positions, while 68° and 74° have nearly the same places as in the Pacific. There is hence a great contrast between the Pacific, South Atlantic, and North Atlantic Oceans. This is seen in the following table containing these results:

	Normal, deduced from Pacific.	Mean position in South Atlantic.	Mean position in North Atlantic.
Isocryme of 74° F.,	20°	7° south.	21° north.
" 68°	27°	19°	28°
" 62°	32°	29°	36°
" 56°	37°	36°	42½°
" 50°	42°	39°	47½°
" 44°	47°	44°	52° (max. 60° north.)
" 35°	56°	50°	61°

The influence of the warm tropical waters in the North Atlantic lifts the isocrymes of 74° and 68° as they approach the coast of America, while the same lines are depressed on the east by the colder northern currents. Moreover, north of 68° the whole in-

* American Journal of Science, xlv, 299, 1843.

terior of the ocean is raised four to five degrees in temperature above the normal grade, by the same waters spreading eastward; and between Great Britain and Iceland, the temperature is at least ten degrees warmer than in the corresponding latitude of the South Pacific, and thirteen or fourteen degrees warmer than in the same latitude in the South Atlantic.*

The influence of so warm an ocean on the temperature of Britain, and on its living productions, animal and vegetable, is apparent, when it is considered, that the winds take the temperature nearly of the waters they pass over. And the effects on the same region, that would result from deflecting the Gulf Stream in some other direction, as brought out by Prof. Hopkins† and others, and substituting in the Northern Atlantic the temperature of the Southern Atlantic, is also obvious, without further illustration. The discussion of these subjects would be foreign to the topic before us.

The subdivision of the oceans into Temperature Regions, affords a convenient means of dividing off the coasts into *Zoological Provinces*. A comparison of the facts afforded by the distribution of Crustacea, with the positions and extent of the Provinces thus deduced, show that they are natural, and may in general be well characterized.

Zoological Provinces have been considered by some as centres of creation, and therefore of diffusion, for groups of species. But such kinds of centres we fail to distinguish in any part of the globe. Each species may have had its one point of origin and single centre of diffusion, in many, and perhaps the majority of cases: but, however the fact may be, we have no *evidence* for asserting that particular regions were without life, and were peopled by migration from specific and predetermined centres; for if there were such centres of diffusion, there are at present no means by which they may be ascertained. The particular temperature-region in which a species was created, may be ascertained by observing which is most favorable for its development; and by this course of investigation, we may find that almost every different locality has some species for which it is especially fitted, we may thus show, as far as reason and observation can do it, that all regions as a general thing, have had their own special creations.

We rather look to climatal influences, in all their various kinds, directly and indirectly exerted, and united with height or depth of site, and other geographical conditions, as giving limits to Zoolo-

* Ross, in his Antarctic Voyage, found the sea-temperature in 60° south and 3° west, 31½° F., in the month of *March;* at the South Shetlands, 61° south, the sea-temperature was 31° to 35° in January (midsummer); and in the same latitude, and 45° west, it was 30·1° in February.

† Quarterly Jour. Geol. Soc., vol. viii., p. 56, and Amer. Jour. Sci., 1853, vol. xv.

gical Provinces; and as regards marine animals, ocean-temperature is the more prominent of these influences. Under temperature, the limits or extremes are to be considered as well as the mean, and also the varying action of currents which induce the changes, especially those occasional extreme results which are of decennial rather than annual recurrence.

How far geological changes, by subsidence and elevation, have varied the distribution of the present races of animals, or given limits to zoological regions, is a point yet uninvestigated. The conclusions that have been derived from this source are mostly of a hypothetical character, and are to be received with distrust without a larger supply of evidence. It is easy to meet a difficulty by the supposition of a former union by dry land of regions now separate; but it appears to us that better evidence is needed on such a point, than those derived from the zoological fact which is to be explained.

Along the various coasts, prominent *capes* are in general the limits of Zoological Provinces; and this fact is well shown in the chart of ocean-temperature. They are, as we have explained, the points where the cold or warm currents are turned off from a coast, and where therefore there is a sudden transition in the temperature. A striking example of this has been pointed out on both the eastern coast of North America, and western of South America, where several isocrymes meet forming a kind of nodal point;—viz., Cape Hatteras, the meeting point of the isocrymes of 62°, 56°, and 50°, and Cape Blanco, the meeting point of 68°, 62°, and (nearly) 74°. So also the east cape of East Australia, is the point of meeting of the isocrymes of 74° and 68°. At the south extremity of Africa, on the west coast of Asia, there are approximations to the same fact. Cape Cod the southeast cape of New England, is a marked point in zoological geography, and the termination of the isocryme of 44° F.; and the North Cape of the La Plata inside of Maldonado is another.

We proceed to give an enumeration of the several Zoological Provinces to which we are led by the temperature regions adopted. It should be again observed, that the isocryme of 68° is the grand boundary of coral reefs, and of the larger part of the zoological life connected with them, and that the *Torrid Zone* and *Coral-reef Zone* of oceanic temperature are synonymous terms.

We mention also the extent of the Provinces; and it will be found, that although seemingly numerous, few of them are under 500 miles in length, while some are full 4000 miles.

For zoological reasons which are explained in another place,* and which may be the subject of another communication to this Journal, we adopt for *Marine* Zoological Geography, three grand

* The Author's Report on Crustacea.

divisions of the coasts of the globe. 1. The *American* or *Occidental* including East and West America; 2. The *Africo-European* including the coasts of Europe and Western Africa; and third, the *Oriental*, including the coasts of Eastern Africa, E. Indies, Eastern and Southern Asia, and Pacific. Besides these, there are the *Arctic* and *Antarctic* Kingdoms, including the coasts of the Frigid Zones, and in some places, as Fuegia, those of the extreme temperate zone. We add here, only in general terms, that there is a remarkable similarity in the genera of Eastern and Western America, and an identity of some few species; that the coast of Europe and Eastern Africa widely differ in Crustacea from either the American or Oriental; that the species of the Oriental division have a great similarity in genera, and that numerous species of Crustacea of Eastern Africa, are identical with those of the Pacific. We pass by, for the present, the details on these points.

We also omit the zoological characters of the Provinces here enumerated. Several of these Provinces are identical with those proposed by Milne Edwards, Prof. E. Forbes, and others; and as far as possible, the names heretofore used, are retained.

I. OCCIDENTAL KINGDOM.

A. Western Section.

1. *Torrid or Coral-Reef Zone.*

Provinces.	Limits.	Length in Miles.
1. *Panamian*, (torrid) . . .	1° s. to 17½° n., . . .	1600
2. *Mexican*, Province, (N. subtorrid)	17½° n. to Californ. Penin., .	600
3. *Guayaquil*, " (S. subtorrid)	1° s. to Cape Blanco, 4¾° s., .	200

2. *North Temperate Zone.*

4. *Sonoran*, (warm temperate) .	Penin. Californ. to 28½° n., .	550
5. *Diego** or *Jacobian*, (temperate)	28½° n. to 34½° n., . .	450
6. *Californian*, (subtemperate) .	34½° n. to C. Mendocino, .	480
7. *Oregon*, (cold temperate) . .	C. Mendoc. to Puget's Sound, (?)	480
8. *Pugettian*, (subfrigid) . .	Puget's Sound to 55° or 56°,	1200

3. *South Temperate Zone.*

9. *Gallapagos*, (warm temperate) .	Gallapagos.	
10. *Peruvian*, (temperate) . .	C. Blanco to Copiapo, 27½° s.,	1500
11. *Chilian*, (subtemperate) . .	27½° s. to 38° s., . . .	700
12. *Araucanian*, (cold temperate) .	38° s. to 49° or 50° s., .	900
13. *South Patagonian*, (subfrigid) .	50° s. to Magellan Straits.	

B. Eastern Section.

1. *Torrid Zone.*

1. *Caribbean*, (torrid) . . .	Key West & N. Yucatan to 1° south of Bahia, .	4000
2. *Floridan*, (N. subtorrid) . .	Key West to 27° n., . .	200
3. *Brazilian*, (S. subtorrid) . .	15° s. to 24° s. . . .	600

2. *North Temperate Zone.*

4. *Carolinian*, (warm temperate) .	27° n. to C. Hatteras, . .	600
5. *Virginian*, (cold temperate) .	C. Hatteras to C. Cod, .	650
6. *Acadian*, (subfrigid)† . .	C. Cod to E. Cape of Newf'dl'd,	900

* May possibly be united conveniently to the Sonoran.
† Changed from Nova-Scotian in the Report on Crustacea.

3. *South Temperate Zone.*

Provinces.	Limits.	Length in Miles.
7. *St. Paul*,* (warm temperate) .	24° s. to 30° s., . . .	480
8. *Uraguaian*, (temperate) . .	30° s. to north C. of La Plata,	360
9. *Platensian*, (subtemperate) .	Mouth of La Plata.	
10. *North Patagonian*, (cold temperate)	South C. of La Plata to 43° s.,	500
11. *South Patagonian*,† (subfrigid) .	43° s. to Magellan Straits, .	700

II. AFRICO-EUROPEAN KINGDOM.

1. *Torrid Zone.*

1. *Guinean*, (torrid) . . .	5° N. to 9° N., . . .	1200
2. *Verdensian*, (N. subtorrid) .	9° N. to 14½° N. including the Cape Verde Islands.	1000
3. The *Biafrian*, (S. subtorrid) .	5° N. to 7° or 8° S., including Ascension & St. Helena,	900

2. *N. Temperate Zone.*

4. *Canarian*, (warm temperate) .	14½° N. to 28° or 29° N. including the Canaries,	1000
5. *Mediterranean*, (temperate) .	29° N. to C. St. Vincent with Mediterranean, excepting some of its northern coasts, and including Madeira and Azores.	
6. *Lusitanian*, (subtemperate) .	C. St. Vincent to 42° N., .	300
7. *Celtic*, (cold temperate) . .	42° N. to Scotland, . .	1000
8. *Caledonian*, (subfrigid) . .	N. Scotland, Shetland's Ferroe, etc.	

3. *South Temperate Zone.*

9. *Angolan*, (warm temperate) .	7° S. to 13° S., . . .	360
10. *Benguelan*, (temperate) . .	13° S. to 28° S., . .	900
11. *Capensian*, (subtemperate) .	28° S. to C. Agulhas, .	450
12. *Tristensian*, (cold temperate) .	Tristan d'Acunha.	

III. ORIENTAL KINGDOM.

I. African Section, or East Coast of Africa and Neighboring Islands.

1. *Abyssinian*, (torrid) . . .	26½° S. to 21° or 22° in Red Sea, including larger part of Madagascar and Islands north,	3500
2. *Erythrean*, (N. subtorrid) . .	Northern third of Red Sea, about	300
3. *Natalensian*, (S. subtorrid) . .	26½° S. to 31° S., with Southern Madagascar and Isle of France.	
4. *Algoan*, (warm temp. and temp.)	31° S. to C. Lagulhas, .	550

II. Asiatic Section.

1. *Torrid Zone.*

1. *Indian*, (torrid)	East India Islands, N. Australia, Southern Asia, to 12½° N. on Cochin China.	
2. *Liukiuan*, (N. subtorrid) . .	12½° N. to 15° N., with Formosa, Loochoos, S. S.E. Shore of Japan.	
3. *Endrachtian* or W. Australian, (S. subtorrid)	W. Australia 22° S. to 26½° S.,	300

* The St. Paul province may perhaps be united with the Uraguaian.

† The South Patagonian is made to include both the eastern and western sides of this portion of the continent; but a division of the two may hereafter be found to be required.

2. *North Temperate Zone.*

Provinces.	Limits.
4. *Tonquin*, (warm temperate) . .	15° N. to 25° N., (Gulf Tonquin.)
5. *Chusan*, (subtemperate) . . .	25° N. into Japan Sea.
6. *Niphonensian*, (cold temp. & subtemp.)	East Coast of Niphon, to 40° N.
7. *Saghalian*, (subfrigid) . . .	Coast of Japan Sea, part of Western and Northern Niphon, Saghalian, Yeso, etc.

3. *South Temperate Zone.*

8. *Cygnian*, or Swan R. (warm temperate)	W. Australia, 26½° s. to S. W. Cape.
9. *Flinders*, (temperate) . . .	Southern Coast of Australia.
10. *Moreton*, (warm temp. and temp.) .	E. Australia, 26½° s. to 31° s.
11. *Bass*, (subtemperate) . . .	E. Australia, 31° or 32° s. to Van Diemens Land.
12. *Tasmanian*, (cold temperate) . .	Van Diemens Land.

III. Pacific Section.

1. *Torrid Zone.*

1. *Polynesian*, (torrid)	Pacific Ids. of Torrid Region.
2. *Hawaiian*, (N. subtorrid) . . .	Hawaiian range of Islands.
8. *Karatongan*, (S. subtorrid) . .	Hervey Islands and others of South Subtorrid Region.

2. *South Temperate Zone.*

4. *Kermadec*, (warm temp. and temp.) .	Kermadec Islands, etc.
5. *Wangaroan*, (subtemperate) . .	Northern New Zealand.
6. *Chatham*, (cold temperate) . .	Middle N. Z. to 45° S. and Chatham I.

The Arctic Kingdom includes (1) the *Norwegian*, north of the Atlantic,—(2) the *Camtschatican*, north of the Pacific,—(3) the *North Polar*: the Antarctic Kingdom, includes (1) the *Fuegian*, Fuegia and Shetlands, etc.,—(2) the *Aucklandian*, Auckland and S. extremity of New Zealand,—(3) the *South Polar*.

Art. XXXII.—*The Coal Field of Bristol County and of Rhode Island*; by President E. Hitchcock.*

In my Reports on the Geology of Massachusetts, I described a large tract in Bristol county, a part of Plymouth county, the whole of the island of Rhode Island, and a strip on the west side of Narraganset Bay, as underlaid by Graywacke; a rock older than the Coal Formation, and equivalent to the Silurian and Cambrian strata of late geological writers. While publishing my Final Report, however, in 1840, I became satisfied that a part of this region was a true coal formation, and so marked it on the map. But I now advance a step farther, and maintain that the whole of this tract, embracing not less than five hundred square miles, is a genuine coal field, that has experienced more than usual metamorphic action.

* From a Report to the Governor of Massachusetts, dated Feb. 23, 1853.

The metamorphic action to which this deposit and the coal have been subject, is two-fold: first, *mechanical*, secondly, *chemical.*

The mechanical force seems to have operated upon the strata containing the coal in a lateral direction, so as not only to raise them into a highly inclined position, but also to produce plaits, or folds, such as would be formed if several sheets of paper, lying upon one another, were taken into a man's hand, and by pressure on the opposite edges, were crumpled so as to form ridges and hollows.

* * * * * *

This same effect has been produced upon the coal strata of Massachusetts and Rhode Island, as well as in the great Appalachian coal field of Pennsylvania and Virginia. The miners are familiar with these irregularities, and they constitute some of the most serious difficulties with which they meet. In the mine of the Blackstone Coal Company, at Valley Falls, R. I., for instance, the bed, and the accompanying rocks, which for a considerable distance dip nearly 45° to the *northwest*, begin to curve so as at length to dip southeasterly.

In the Aquidneck mine, at the north end of Rhode Island, the bed of coal that had been worked, was in some places pinched up to a width of not more than one or two feet, while in other places it has a thickness of from ten to fifteen feet. I noticed here also, another peculiarity, which it is difficult to describe intelligibly without drawings. It is this; that the foldings do not run either perpendicular or parallel to the strike (direction) of the strata, but obliquely. Hence, when a thick mass of coal is reached, it passes into the earth between the strata in an oblique direction, and other expansions (as well as the contractions) of the bed, will run parallel to it. This fact will be of some practical value, but, perhaps, its chief interest lies in its scientific bearings.

Another effect of this plicating force has been to crush the coal, so that when dug out, it crumbles too much, and produces a great deal of fine coal. Sometimes the coal appears as if it had been severely squeezed and made to slide along between the strata. I find it to be a common impresion among those familiar with these mines, that the force came from the northwest. But in the Aquidneck mine, the direction of the folds (somewhat southeasterly,) would indicate a pressure either from the N. E. or S. W.

The chemical metamorphosis which these rocks have experienced, consists mainly in such effects as heat would produce. By an inspection of the map appended, it will be seen that this coal basin is in a great measure surrounded by unstratified rocks, such as granite and syenite,—which all geologists now admit to have been once melted. I have never seen any example in which they have sent veins into the coal strata: a fact that seems to indicate that the latter were not deposited till after the granite and syenite

were partially cooled. Yet along the margin of this coal field, especially at Newport, all along the west shore of Narraganset Bay, at Smithfield, Cumberland, Wrentham, Bellingham, &c., we find the slates very much metamorphosed, so as only heat could have done it. I infer, therefore, that these slates were deposited while great heat yet existed in the subjacent unstratified rocks; and although the coal strata may be newer than the metamorphic slates, yet they also show a greater degree of induration, and in some instances more of crystallization than is common in undisturbed coal fields; and cross seams, or divisional structures, are also more common than usual. These too, are now usually referred to the action of heat. The coal, also, from this basin, has a greater specific gravity than most anthracite; bearing a proportion to the Pennsylvania anthracite, of 1·75 to 1·55. It has a tendency greater than usual, to break into cuboidal fragments, and has more the shining aspect of crystalline minerals. I ought to add, that in some of the mines, the metamorphic action has been so great as to obliterate all traces of organic remains. This is so remarkably the case at a coal bed, seven feet thick, in Worcester, that no trace of a vegetable has to my knowledge ever been discovered there, and the anthracite has a still more stone-like aspect, is heavier than that from Rhode Island, and is partially converted into plumbago. Yet, even this, most geologists would not hesitate to pronounce a genuine coal formation.

Such are the chief circumstances that have so long perplexed the geologists in respect to the age of the coal of Rhode Island and Massachusetts, and made them hesitate whether to regard its age as precisely equivalent to that of the regular coal formation. But at length the evidence is too strong to resist, that this deposit belongs to a true coal field, and is of the same age as the great coal deposits in our own country in Pennsylvania, Virginia, Ohio, Michigan, Illinois, and Iowa; and those of England, Scotland, France, and Belgium. The only difference seems to be, that this **is a metamorphic coal field.**

Such an identification of this deposit is a point of great importance in forming a judgment of its value, and it therefore seems desirable that the evidence should be presented. This will involve a description of all the important facts with which I have become acquainted respecting this coal field.

I. *In the first place, the general outline of the surface over this field, corresponds with that of a regular coal field, or basin.* It is generally nearly level, save some gentle swells and a few outliers of rock, the remnants of former more extensive masses. On its margin the older and more crystalline rocks rise higher, though not very much so; for there is reason to think that both the margin and the surface of the coal field have been subject to powerful denudation.

By this argument I intend merely to show that there is no improbability in the supposition that this basin of five hundred square miles, may be a coal field; just because it looks like one. But the argument has no great force; because other deposits may exhibit a similar surface. Strictly speaking, it merely shows that the surface is underlaid by one formation, or by closely allied formations.

II. *The rocks correspond essentially to those of the coal measures.* The predominant varieties are four: 1. A dark colored slate, or slaty clay, often much indurated, and more or less charged with carbon, lying in immediate contact with the coal, especially beneath it. Its surface is sometimes highly glazed, as if by heat, or friction. I noticed fine specimens at the Roger Williams mine, a mile or two north of Valley Falls, Rhode Island. 2. A coarse light gray grit, or sandstone, lying, so far as I have observed, immediately above the coal beds, and easily disintegrating at the surface. 3. A dark gray, hard grit, or sandstone: a much more extensive rock, forming in fact the principal one between the beds of coal, and in some places embracing coal without the intervention of shale. 4. A coarse gray conglomerate, which probably underlies the other rocks above described, and may be the equivalent of the millstone grit that forms the basis of other coal fields. I do not feel satisfied, however, that such is always the position of this rock. Further examination is needed. This rock occurs in various places along the eastern part of Massachusetts; but nowhere, that I know of, associated with coal, save in the Bristol coal field.

Several other varieties of rocks exist on the borders of this coal field, but whether they are the coal measures metamorphosed, or older rocks, such as the Devonian and Silurian, is not certainly known. They consist of gray and red slates, and red sandstones and conglomerates. As to the red varieties, I have little doubt but that they belong to the Devonian or old red sandstone system, and have accordingly so represented them where they are most fully developed, viz.: in Wrentham and Attleborough. In the south part of the former town, this red rock forms a striking feature in the landscape. I found it there, by the Aneroid barometer, to rise about four hundred feet above the general surface at the Mansfield coal mines, and three hundred feet above the excavation once made in Wrentham for coal. On this hill I found the red rock to have a strike E. 10° N., and a dip 70° southerly; so that it must pass beneath the coal field, as we should expect if it were the old red sandstone. A mile south of the meeting-house in North Attleborough, however, where this red rock (here mostly a conglomerate) shows itself, the strike is E. 15° N., and the dip 35° northerly. This fact looks as if we might here be on the southern border of a coal basin, and at Wrentham on the northern border, and that there may be an axis of the older rocks running

northeasterly across the coal field. But this point needs further examination, and I have not given such a view of the matter on the map. But I thought it best to indicate the region where I have seen the old red sandstone, as I presume to call it, most fully developed.

Now, setting aside these border rocks, and looking only at those in connection with the coal, I think we cannot hesitate to identify them with those of other coal fields; though, perhaps in Massachusetts and Rhode Island rather more metamorphosed than is common.

III. *The number, position, strike, dip, and general character, of the beds of coal, already discovered in the district under consideration, render it probable that it is all one coal field, or essentially one.*

Under this head I am led to describe briefly all the coal beds in this deposit known to me, most of which have been explored to a greater or less extent. I have visited them all, with one or two exceptions of no consequence; and descended into all the mines that are accessible.

1. *Beds of coal in Mansfield.*—These have been opened in two parts of the town. One is near the centre where a shaft was sunk by the Mansfield Coal Company, some fifteen years ago, sixty-four feet; but only a little coal was found.

About the same time, the Mansfied Mining Company sunk a shaft eighty-four feet near the Hardon farm, two miles southwest of the centre. A drift was then carried across the strata, and it is said that seven beds, of various thickness, up to ten feet, were found. Dip of these beds, 53° N. W. Strike, S. W. and N. E.

More recently, in 1848, I believe, the Mansfield Coal and Mining Company, through the enterprise and perseverance of B. F. Sawyer, Esq., sunk a shaft near the same place, one hundred and seventy feet, and ten feet in diameter: from which, according to the statements of Thomas S. Ridgway, Esq., the engineer, they have carried a south tunnel six hundred and sixty feet, and other tunnels and gangways to about the same amount. Not less than thirteen beds of coal have been crossed, but none of them thick. They are very irregular, sometimes swelling out to six or eight feet in thickness, and then pinched up to a few inches. The dip varies from 30° to 70° N. W., and the strike is nearly N.E. and S. W. Although these excavations are not far from the old Hardon mine, the beds are said to have little correspondence.

2. *Bed in Foxborough.*—This is only about two miles from the Mansfield beds, and two excavations were made there several years ago, and good coal obtained; but the pits are filled up so that I could not ascertain the strike, dip, and width of the bed.

3. *Beds in Wrentham.*—In the south part of the town, a pit was sunk many years ago, about one hundred and eighty feet, mostly in dark carbonaceous slate, and several beds found. The

coal which I have seen from this spot is not good, having forty per cent. of ash. Strike of the bed, nearly E. and W.; dip, 45° N.

4. *In Raynham.*—An outcrop of coal appears in this town, about three feet thick, which has not been explored, except a few feet. Strike, N. 50° E.. dip, 45° S. E.

5. *In Bridgewater.*—Indications of coal were shown me from the rock thrown up in digging a well in the south part of the town, but nothing further could be learned.

6. *In Taunton.*—Two miles northwest of the town, a similar opening was shown me, but I could not learn the dip and direction of the slate. Four miles to the west of the town, I was told that similar indications existed. The same is true of West Bridgewater; and in Berkley coal plants are found, such as usually accompany beds of coal.

7. *In Cumberland, Rhode Island.*—This is called the Roger Williams mine, which was opened many years ago; but the works were burnt, and the explorations abandoned. But they have been resumed within a few years, under the superintendence of Capt. Thomas Martin. A shaft has been sunk three hundred feet perpendicularly, into which I descended, with Capt. Martin. The old bed, whose strike was nearly N. E. and S. W., has been abandoned, and by carrying a horizontal drift two hundred and sixty feet, a new bed was struck, which, at the place, runs nearly N. and S., and dips west about 45°. The average width was stated to be fifteen feet, and in some places twenty-three feet. If this be not a mere protuberant mass, occasioned by lateral pressure, it indicates a larger amount of coal than I have seen in any other mines in this coal field.

8. *The Valley Falls Mine.*—This is scarcely more than a mile south from the Roger Williams mine: yet the strike of the beds will not allow us to suppose them connected. The operations here are carried on by the Blackstone Coal Company. A shaft is carried down, which follows a bed of coal, with dip near the surface of 30° to 45°. This bed, which I examined several years ago, to the depth of about fifty feet, exposed a thickness of coal from six to nine feet, and the direction was N. 50° to 60° E. Since that time, the "incline," as the miners call it, has been pushed downward five hundred feet, or about three hundred and seventy-five feet of perpendicular depth, and, as already mentioned, the strata have been found to curve very much, and not less than five beds of coal have been crossed; the best having a width of six feet. One nest of coal was found thirty feet square.

9. *In Seekonk.*—I am informed by J. N. Bolles, Esq., of Providence, that the outcrop of a bed of coal was found in digging a well in this place, only fifteen feet from the surface. Its quality was similar to that found at Valley Falls. In the same region occur very fine specimens of coal plants, especially Calamites.

10. *In Providence.*—The same gentleman, in boring for water, in the north part of Providence, at the depth of sixty feet, struck a bed of coal dipping N. E. 45°, which is ten feet thick, and of the same general character as that at Valley Falls, which is known to burn well.

11. *In Cranston, R. Island.*—This town is on the west side of Narraganset Bay, along which the coal rocks extend as far as Warwick. In Cranston, according to Dr. C. T. Jackson, "slate, graphite, and impure anthracite," are found in an excavation seven or eight feet deep. Coal plants are very abundant on Warwick Neck; but no coal has been found.

12. *In Bristol, R. I.*—The coal bed in this place is in the west part of the town, and the spot where it crops out is only a few feet above the harbor. It was discovered in sinking a large well. Although I descended into it, I could not ascertain the thickness of the bed, nor with accuracy its strike and dip. Approximately it runs N. a few degrees E., and dips westerly about 48°. The coal did not appear to me to be as much crushed as in some mines, and seems of an excellent quality.

13. *Portsmouth Mine, or Case's Mine, in Rhode Island.*—This mine, situated in the northeast part of the island of Rhode Island, was opened in 1808, which was earlier than the Pennsylvania mines were explored. At that time the mode of burning anthracite was not known, and the coal was not sought after, and the work was abandoned in 1813 or 1814. Some years afterwards it was resumed, and in 1827, according to Mr. Clowes, the agent, twenty men and five boys raised about forty-four hundred tons of coal, coarse and fine. But the work was again abandoned not long after, and not resumed till 1847, when the mine was opened by the Portsmouth Coal Company, which has also ceased operations there. Mr. Barbour speaks of the amount of coal and rock, "principally the former," that has been excavated at this place, as about one hundred thousand tons.

Three beds were discovered at this place, "all of workable width." Dr. C. T. Jackson says that the bed last wrought was thirteen feet thick. He states its strike to be S. 80°, W. and N. 80° E.; dip 35° southeasterly. Mr. Clowes, however, says that the beds run N. E. and S. W., and dip from 40° to 90° southeast. As the mine is now unwrought I could not settle these points.

14. *The Aquidneck Mine.*—This is in Portsmouth, and only about two miles west of Case's mine. Indeed there is reason to suppose, that while the latter occupies the northeast side, the former is situated upon the northwest side of the same coal basin. The strike of the strata and coal beds is N. a few degrees E., and the dip of the bed now wrought, varies from 28° to 35° S. E. Three beds of coal occur, only one of which has been wrought by the Aquidneck Coal Company, which bed, I was told, varied

in width from two to twenty feet. They have followed down the middle bed to the depth of six hundred and twenty feet, from which six gangways have been extended, from eighty to eight hundred and forty-four feet each. During the last half of 1851, thirty-one hundred tons of coal were taken out, and an opening is now made into a subjacent bed. The appearance of the operations at this mine, under the superintendence of Arad Gilbert, Esq., and the quality of the coal, appeared to me more satisfactory and promising than at any other mine in this coal field.

The mouth of this mine is not more than twenty feet above the ocean, and only a few rods distant; yet, after descending about one-third of the distance, to the bottom of the inclined shaft, I found the mine quite dry, although at the bottom, I was some hundreds of feet below the waters. The coal appeared to me less crushed at this mine than at most others; yet the bed is very unequal in width; showing that the folding agency has here operated.

The opening of this mine is several hundred feet lower than that of the Case mine. The latter, however, I have understood to be subject to the influx of water, but I cannot learn how deep it was ever wrought. I consider the question whether these two mines are opened on the same bed, as yet quite unsettled. Both of them lie near to protruding mines of granite, and have been subject to a good deal of disturbance.

15. *In Newport, R. Island.*—In the southeast part of this town a thin bed of coal shows itself on the coast, where the dark strata of slate stand nearly perpendicular, and have a direction nearly east and west. During the revolutionary war, the British made some excavations at this spot, in the hope of finding fuel. But the prospect is very poor, especially as the spot is so near granite, which has affected the strata. Yet at this place the shale abounds in coal plants.

Let me now present, in a tabular form, the leading facts respecting these fifteen localities, where coal has been discovered in this field; at least in those cases where the facts are definite enough to tabulate.

Locality.	No. of Beds.	Thickness of do.	Strike of do.	Dip.
Mansfield, Centre, .	1	A few inches,	N. E. and S. W.,	N. W., large.
" Hardon,	7	10 feet,	N. E. and S. W.,	53° N. W.
" New, .	13	7 feet max.,	N. E. and S. W.,	30° to 70° N. W.
Wrentham, . . .	1	— —	E. and W.,	45° N.
Raynham, . . .	1	3 feet,	N. 50° E.,	45° S. E.
Cumberland, . .	2	15 to 23 feet,	N. E. & S. W. & N. & S.,	45° W.
Valley Falls, . .	5	6 to 9 feet,	N. 50° to 60° E.,	30° to 45°
Providence, . . .	1	10 feet,	N. W. and S. E.,	45° N. E.
Bristol, ...	1	— —	N. somewhat E.,	48° N. W.
Portsmouth, Case's,	3	13 feet max.,	N. E. and S. W.,	40° to 90° S. E.
" Aquidneck,	3	2 to 20 feet,	N. a few degrees E.,	28° to 35° S. E.

The geologist will notice two circumstances of importance in the preceding facts; one is, that there is a tendency to a northeast and southwest direction in the beds of coal. The other is, that where horizontal drifts of any considerable extent have been carried across the strata, several beds have been crossed. The exceptions in the dip can easily be explained by the proximity of the older crystalline rocks, which may have greatly changed the direction, at least for some distance; and the opposite dips observable in some cases, may be referred to the same cause, or perhaps to an anticlinal axis of older rocks, which I have some reason to suspect, may cross this coal field in a N. E. and S. W. direction.

It seems to me difficult to avoid the conclusion, that these different beds, scattered as they are so widely, all belong to one and the same coal field; although denudation or vertical movements may have rendered some parts of it much less productive than others. The strike and dip, as well as the number of beds, correspond as well to other coal fields as we ought to expect, when we consider the great amount of metamorphic action which has here been exhibited.

It ought to be known, too, in this connection, that this region is densely covered by accumulations of drift, and the sand and gravel of ancient sea beds. Especially is this the case where the rock is the softest,—that is, the black shale,—which contains the coal beds. Hence rocks rarely show themselves at the surface, and the wonder is, that so many beds of coal have been discovered, rather than that no more have been found. The digging of wells and other excavations have been the principal means of bringing them to light; nor will any reasonable man doubt that probably many more are concealed beneath so thick a coating of drifted materials.

IV.—*The character of the vegetable remains found in connection with these coal beds, make it almost certain that they belong to the coal measures of the carboniferous system.*

[Figures of species of Stigmaria, Calamites, Pachypteris or Odontopteris, and Neuropteris, on two plates, are here referred to.]

I might add several other species of plants peculiar to the coal formation, and found in this field. But it seems to me unnecessary. Those already exhibited appear to settle the question as to the true place of these deposits, in the geological scale. No geologist would think of putting them in any other part of the series than the carboniferous. I have not, indeed, met with any specimens in these rocks, of Sigillaria and Lepidodendra, which are common in the coal rocks of Pennsylvania and Ohio. But it is more easy to explain their absence from a real coal field, than the presence of so many other plants, identical with those of the coal measures, in any other formation.

In view of all these proofs I am led to the inference that this is a genuine coal field of the carboniferous series. And the tendency to a northeast and southwest direction in the beds, as well as the high dip, leads strongly to the conclusion, that this is only a detached portion of the great Appalachian Coal Field, which stretches through the Middle States.

In comparing the character of this deposit with those of European coal fields, I am led to regard it as very similar to the *Upper Culm Measures* in Devonshire in England. These are composed of "sandstones and indurated shales, (the latter containing the Culm or Anthracite,) and are of great but unascertained thickness, being perpetually interrupted, coiled upon themselves, and repeated over again, forming an incredible number of anticlinal and synclinal lines." (*Ansted.*) A considerable number of beds of coal occur in these rocks which are several feet thick, and they are more or less extensively wrought. Only a few years ago, some of the ablest English geologists (De la Beche and others) contended that these rocks were not true coal measures, but considerably lower in the series. Yet I believe they are now universally regarded as belonging to the carboniferous system, and on the same evidence as I have just adduced, viz.: the organic remains. The Devonshire beds seem to be more changed by metamorphic action than those of the Bristol coal field, if we may judge from the fact, that the vegetable impressions are more distinct here than in England.

In Brittany, Normandy, le Maine, and Anjou, in France, according to the French geologists, analogous rocks occur, containing beds of anthracite more than three feet thick. And though referred by some to the Graywacke strata, they are at last taking their place in the true carboniferous system, as are also the anthracite strata of the Alps, which have been regarded as newer than the coal formation. (*See Quarterly Journal of Geology for August*, 1851, p. 91.)

The evidence, then, seems very strong, on which I base the conclusion that the Bristol and Rhode Island deposits, with vegetables remains, possess the age and characters of a true coal field as the carboniferous period of the geologists. And if it be indeed so, much greater confidence of success may be entertained in the researches after coal, which have for some years been making, than if we could assign no settled place to the rock, or that place were higher or lower than the carboniferous system. * * *

Art. XXXIII.—*Researches on Different Applications of Magnetic Attraction;* by M. J. Nicklès, Doctor in Science.

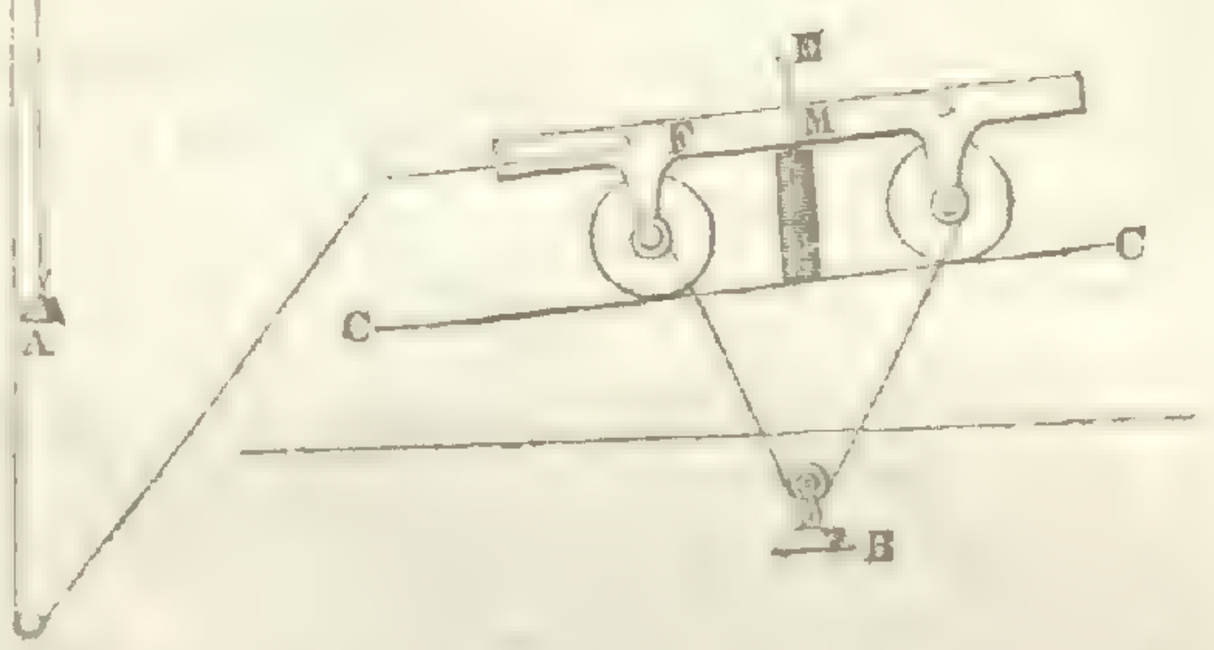
Part I.—*Use of Magnetic Attraction in Locomotion on Railroads.*

The researches here described, have been in progress three years. Their object has been to give to the driving wheels of locomotives a power of adhesion independent of pressure or weight, an adhesion consequently that will not vary with the grade, and which at the same time may be suspended or brought into action at will.

My first experiments were made in conjunction with a Paris mechanician, M. Amberger, who had called my attention to this subject by consulting me as to the means which physical science could furnish toward it. My first idea was to make the driving wheels electro-magnets; but not finding in known facts sufficient data for magnetizing a wheel in motion, I undertook provisionally to use an electro-magnet acting, at a distance, upon the rail, and fixed upon a support moving upon the railroad.

This apparatus consists of a framework of iron, F, (fig. 1.) moving on 4 wheels in pairs, to which a rotatory movement is imparted by means of a weight B, acting on the wheels in place of steam. Another weight A, fixed at the extremity of the car by means of a cord, represents the resistance, or the charge to be drawn.

1.



This car was placed on a railroad C, whose grade could be varied. At M it carried a horse-shoe magnet E, placed across the track, and so that its arms were separated by the distance between the rails. This electro-magnet, one arm of which only is represented in section in figure 1, consists of a bar of iron 1 centimeter in section, bent into a horse-shoe form, and having each arm furnished with about 250 turns of copper wire 1 millimeter thick. The poles of this magnet were about 4 millimeters from the rail on which they were to act. The pile consisted of two of Bunsen's elements as modified by Deleuil.

The first experiment was made on a grade of 80 millimeters to the meter. The car was put on the rails and the weight B left to fall by its gravity, and so give motion to the wheels about which the cord was wound. Under this force the car tended to pass over the rail, and motion began when the weight A was removed; although the adhesion was sufficient for transporting its own weight, it was not enough to balance the resistance exerted by A, (A representing the train to be drawn.) The addition of the electro-magnet was intended to give to the driving wheels

this supplement of adhesion, and in fact, on closing the circuit, the car passed over the rails without difficulty; on breaking the connection again, it stopped and fell back on the track. The weight A used in the experiment was two kilogrammes, and the motor weight B about six. The figure is reduced to one-fifth the lineal dimensions.

In this experiment, the adhesion derived from the weight of the engine was obviously replaced by another force differing in being independent of the grade of the track, since the magnetic attraction always acts perpendicularly to the plane of the armature whatever may be the position or inclination, while gravity acts at right angles to a true horizontal plane. The constancy of the magnetic adhesion is proved by means of a piece of apparatus which is described below.

Although this experiment was so simple and unpretending, it afforded an encouraging demonstration of the problem in view, and it has interested the different professors of physics of Paris, MM. Despretz, Becquerel, Silbermann, etc., who have exhibited it in their courses, as well as the other experiments below detailed.

The process just explained would certainly have been very simple, if the successful application on a large scale had required only that an electro-magnet should be placed on each side of the driving wheels. But this method would not stand the most elementary considerations. The attraction diminishes as the square of the distance; and moreover the magnetic adhesion not exceeding $\frac{1}{10}$ the power of the magnets at 4 millimeters distance,—since the adhesion is, at a mean, $\frac{1}{10}$ of the pressure—the required force would not be realized even with batteries of great power.

The only possible method seemed then to consist in magnetizing the point of contact, which was accomplished as follows. Figs. 2 and 3 rep-

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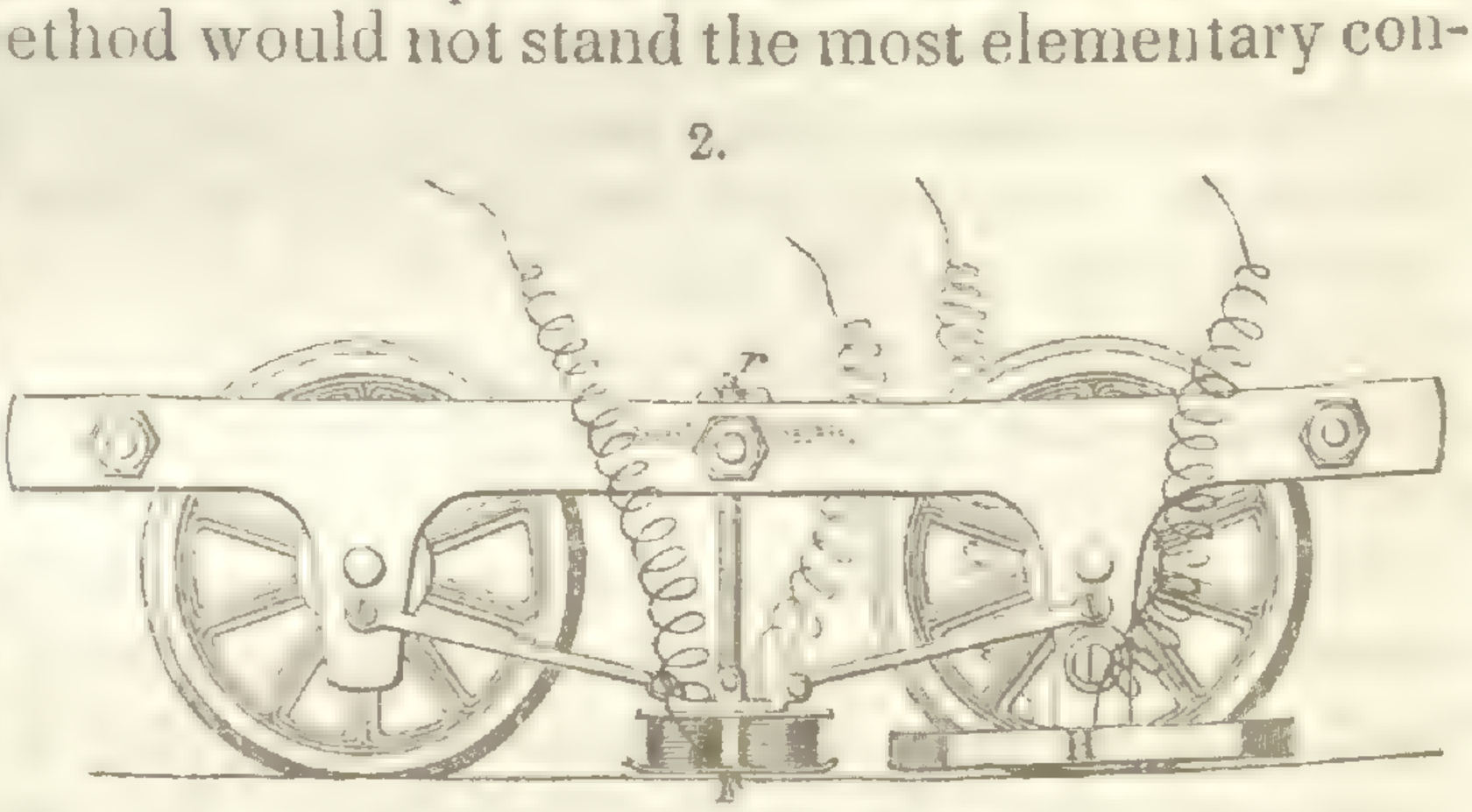

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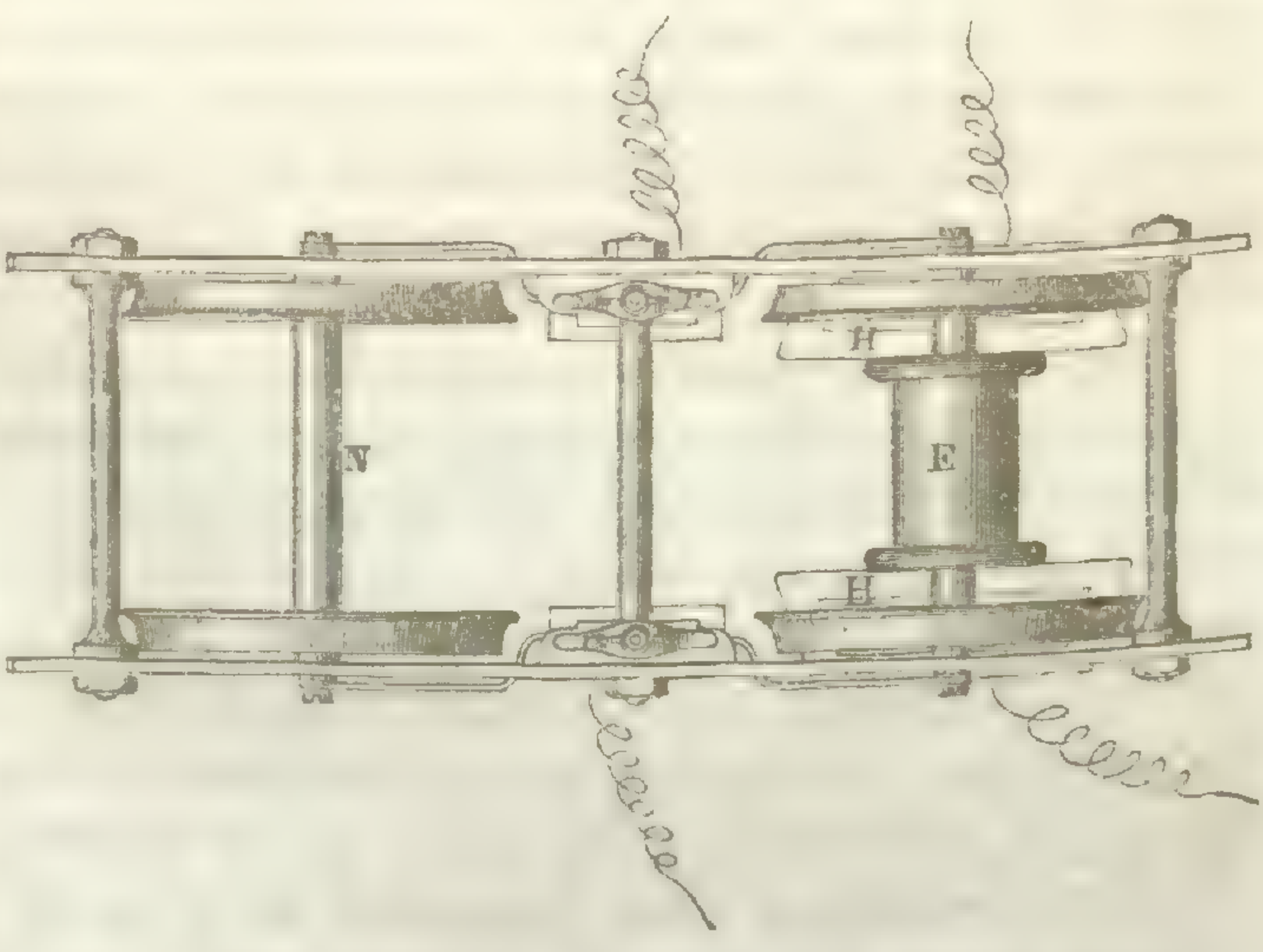
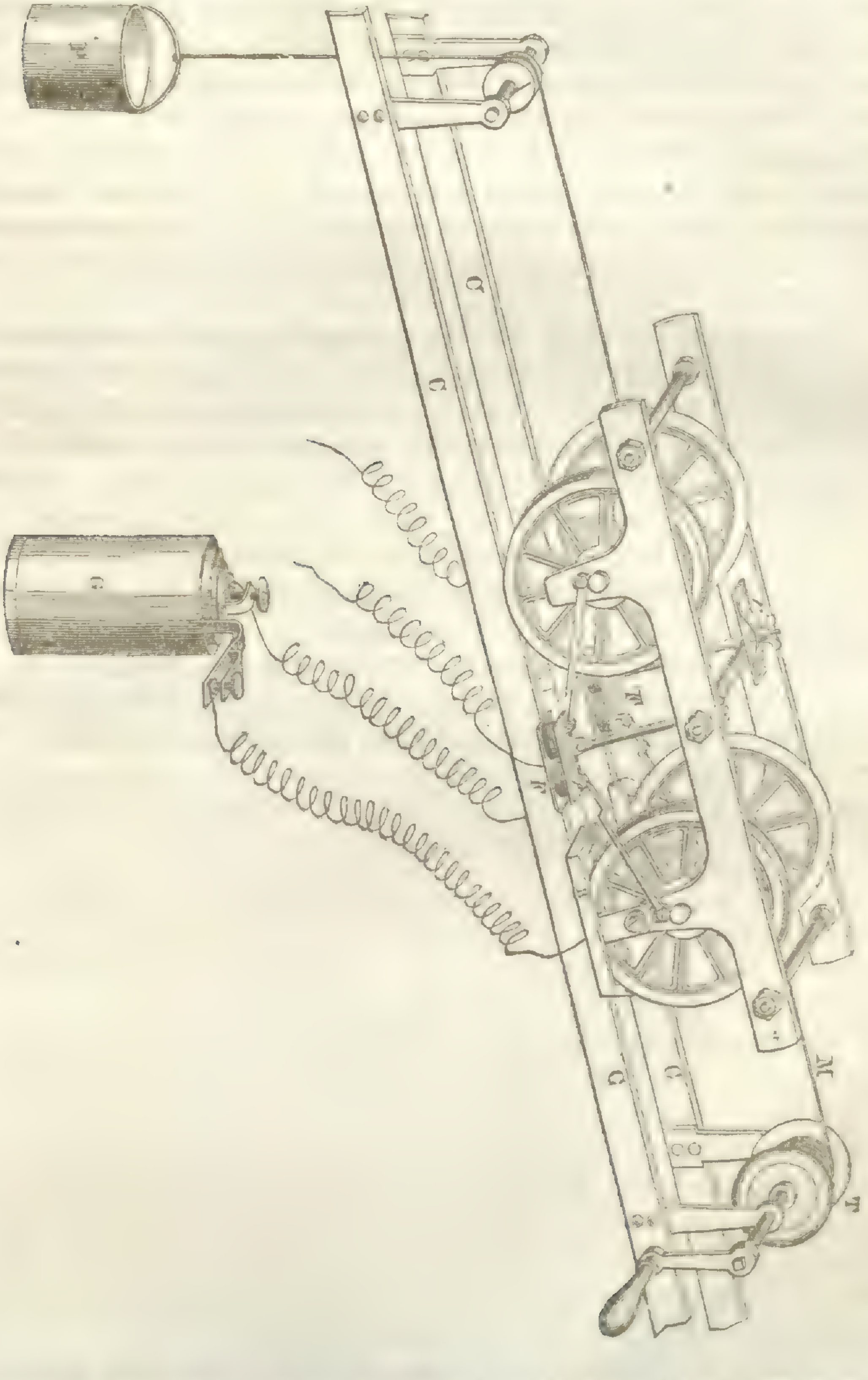


resent different views of a small car which in figure 4 rests on a railroad. The driving wheels of this car are surrounded in their lower part by a helix H, containing a conducting wire wound a certain number of times on itself, and constituting thus a true

4.



magnetizing helix. It is fixed, and embraces the lower part of the wheel; its inner sides are far enough apart for the wheel to turn freely without touching the helix. On passing the electric current, the wheel feels the two fluids, one, the boreal, for ex-

ample, influencing the part of the wheel above the helix, the other, austral, the lower portion; and as the helix is placed as near as possible to the point of contact, this last portion must be more strongly magnetized than the upper, the austral being concentrated on the smaller space.

The apparatus in figure 4 served to verify these different effects. The roller T is for receiving the cord which is wound upon the motor axle E (fig. 3), and which corresponds to the moving power; P represents the train to be transported.

The weight P is increased until the car is ready to slide back; as soon as the motion ceases, the current is let on, and immediately the car starts off and draws the weight P; it descends again if the circuit is broken, and reascends on establishing it again, and so on.

In this apparatus, each of the helices H and H′ consists of a brass box containing each 8 meters of copper wire of $0^{m}{\cdot}0071$ in diameter, distributed in 77 turns, or 16 meters and 154 turns for both. The cord which sustains the weight P is fixed on N (fig. 3) and passes over the pulley behind; G represents a voltaic couple; C a railroad track, arranged so that the grade may be varied.

The following trial gives nearly the relations existing between the two modes of adhesion operating in this apparatus and between the pressures which produce the adhesion.

Weight of car 5 kilogrammes. Grade 190 millimeters to the meter. One element of a battery of gas carbon. Total current tan 35° 10′. Reduced current of the helices, tan 18° 25′.

Weight required for motion.		Sum of adhesions.	Additional weight required to replace the magnetic adhesion.
Ordinary adhesion.	Magnetic adhesion.		
5·500 kil.	5·100 kil.	10·600	3·500

The two driving wheels were fixed to the rails with a magnetic force equivalent to $3\frac{1}{2}$ kilogrammes;—this force was measured by means of a dynamometer, with which the car was detached in a direction perpendicular to the plane of the track.

This experiment clearly proves, that between the magnetic pressure and its adhesion, there is the same relation as between the ordinary adhesion and the pressure by added weight. From another experiment we have also learned that the same relation subsists between the attraction exerted by an electro-magnet, on a surface of iron, and the weight required to make it move. The magnetic co-efficient for moving equals closely, the co-efficient afforded by a mass of iron whose weight was equal to the magnetic pressure exerted by the electro-magnet.

In the apparatus of figure 4, there is also on each side an electro-magnet F, fixed to the grease boxes, and suspended by means of springs, *r*. These electro-magnets act as a check; unlike the checks in use on railroads, they act upon the rails, and thus preserve the wheels which are rapidly worn by the ordinary checks;

there is nothing to prevent making the magnetic checks to act upon the wheels. In either case, a power as energetic as desired may be developed, whose intensity may be varied at will, from that required to produce an instantaneous arrest of the motion, as in cases of imminent danger, to that for ordinary stoppages.

These different effects were produced with the small car represented in figure 4. The element of a galvanic battery here employed, gives a force sufficient to stop the car instantly, even when driven at full speed it arrives at the bottom of a grade of 190 millimeters. By diminishing the current or augmenting the charge, we produce on the contrary an effect which retards the motion of the vehicle and ends by stopping it altogether. By interrupting the current and reëstablishing it in turns the car may be made to leap along the track. These different effects, which are not well attempted with a large train, are readily shown on a small scale, and are calculated to interest much the young student.

But it will be understood that my researches aim not merely to exhibit a new property of electro-magnets, and combine them in instructive apparatus. My plans are of another kind. They seek to contribute to railroads, a new and important improvement, and I shall not be satisfied until it has become easy to use grades of more than 10 millimeters to the meter, and until it shall become no longer necessary to construct tunnels at great expense or to build extensive earth-works, or make curves of large radius. Of what avail otherwise the efforts to give a smaller size to the driving wheels, less weight to locomotives, lighter rails to the road, thereby to make a large diminution of expense in the construction and use of roads? If a smaller and lighter driving wheel be invented, the adhesion must be imparted to it which it fails of having on account of its lightness, and hence it must be useless under the old system which works upon the paradox of making a machine run better by giving it more weight.

I have therefore sought to pass from the laboratory experiment to the actual locomotive in its own field. I have made my trials on the road between Paris and Lyons. The locomotive put at my disposal was, in truth, somewhat worn by long service, and one of its driving wheels carried a ton of weight more than the other. I was not allowed to make any changes in the machine, and I was required to attach my apparatus in such a way that it might be easily removed. Notwithstanding the unfavorableness of these conditions I went to work, certain of having an effect sufficient to prove the application possible. This was admitted by a commission appointed by the minister of Public Works, consisting of MM. Pouillet, Regnault, Froment, Le Chatelier, Chatelus and Sauvage, chief engineer of the Lyons railroad. The useful effect observed in this experiment was about 9 per cent.

Under the new conditions, obstacles were encountered which were unknown in my laboratory researches. Still, without modifying the wheels, which was not allowed, I undertook to apply the method of magnetization above described.

As the experiments have led to some curious results not devoid of scientific interest, I will enter into some details which may at least serve for verification, and will excite the attention of physicists engaged in this department of electro-magnetism. The points which will especially engage my attention in this essay will be the battery, and particularly the helices. The helices when once constructed must remain as they are, while, by the different modes of combination of which a battery is susceptible, we can always apportion more or less the tension of the fluid to the resistance to be overcome.

Helices of Magnetization.

Considering only the works hitherto published on magnetization, the nature of helices should be easily resolved. In fact, according to Dal Negro, Fechner, Lenz and Jacobi,*

1. *The magnetic intensity developed is proportioned to the intensity of the current.* The nature of the application is opposed, it is true, to a galvanic development of great power; but it may be supplied, if, as Lenz and Jacobi conclude,

2. *The attraction is proportioned to the intensity of the current multiplied by the number of turns in the helix;* and with much more reason, if as says M. Dub,†

3. *The magnetic attraction developed, is proportional to the square of the current multiplied by the square of the number of turns of the spire;* a law which ten years since Mr. Joule‡ expressed in the formula, $M = E^2 W^2$, M, representing the magnetism developed, E, the quantity of electricity in activity; and W, the length of the conductor.

Moreover, MM. Lenz and Jacobi, say that "*the section of the conducting wire is without influence on the magnetizing force, provided the galvanic intensity does not vary;*" and as the resistance offered by the conductors is proportional to their length and inversely as their section, a battery and helix may be constructed such that the number of turns of the helix shall be the greatest possible. Happily I have had occasion to observe that Mr. Joule's formula is not exact, or at least does not apply in such a case as this; the law of magnetic maximum of M. Müller is on the other side opposed to it.

These doubts and contradictions, and the necessity of further experiment, complicates much the problem in hand. I have how-

* Poggendorff's Ann., xlvii, 225. † Poggendorff's Ann., (7) lxxxi, 46.
‡ Phil. Mag., [4] vii, 309, and Annals of Elect., i, 470.

ever, succeeded in meeting the several points, and in making the resistance of the battery equal with that of the conducting wire, without too considerable a development in either the battery or helix. The wire was $4^{mm}\cdot5$ in section, with a total length of 1036 meters; each helix received 518, forming 216 turns.

The battery consisted of 64 elements of Bunsen made with gas carbon; the surface of the carbon in each element was $0^{m}\cdot911$; that of the zinc immersed $0^{m}\cdot9148$. These 64 elements were arranged in 8 cases, having each compartments covered with gutta percha, as has been done by Prof. Page. The whole was placed behind the tender. In this position the battery was out of the way, and hardly seen in the train.

This battery whether arranged for tension, or coupled for quantity in series of 32 elements with double surface, produces the same results whenever an equivalent direction is given to the current. Thus when arranged for tension, a single current is produced; and when for quantity, the current is diverted on arriving below the machine, so as to form a distinct current in each helix; two conductors of copper wire answer in this experiment which is not quite delicate in other respects on account of the excessive conductibility of the materials which enter into the construction of a locomotive. These conductors were lodged in tubes of gutta percha, which were themselves covered with chamois leather, that was impregnated with varnish especially where these tubes are directly supported by iron. On reaching the point of junction of the tender with the machine, these conductors are adapted to the conductors fixed to the locomotive, being bifurcated with them in a way to avoid rupture from the vibrations of the cars while in motion. From thence, they follow the left side of the locomotive, penetrate under the machine between the furnace and one of the driving wheels, and are then continued parallel to the machine, half way to the helices. Being firmly fixed to the points of attachment presented in great number under the machine, these conductors are denuded where they receive the extremities of the wires proceeding from the helices. These last were suspended to the grease-boxes by means of strong clamps and a plate of iron.

Thus arranged, one of the conductors is continuous from one extremity to the other; the other conductor on the contrary, has a break produced by the commutator. On arriving near the iron seat ("coffre") on the front of the tender, breast-high, this conductor diverges from the line which it has before followed. and is secured to the extremity of a plate of platinised copper, attached solidly to the seat, and carefully insulated. The other side of this connecting plate is destined to receive the extremity of the interrupted conductor which is in contact with one of the poles of the battery.

This part of the conductor is flattened, so as to present a convenient surface; a spring holds it off from the plate, and in this state the circuit is open; to close it, a key is touched which acts on the conductor, and presses it upon the connecting plate; and it is broken by a contrary movement, when the spring throws off the conductor.

On making the battery connection, a magnetic radiation is perceived to a great distance, so that at 5 meters from the wheel in the plane of the helix, small strips of iron may be magnetized.

The result of the experiment made with the apparatus just described, has been made the subject of a report to the Minister of Public Works, by the commission already named. The following numbers are cited from this document.

The trial was made on a grade of 10 millimeters to the meter. The elements of the machine, were as follows;

	Meters.
Diameter of pistons, - -	0·400
Play of the pistons, - -	0·600
Diameter of the driving wheels,	1·600
Heating surface of the fire, -	779·600
" " " tubes, -	7·860

Weight of the machine provided with its water and coke, - - - - - - 29 tons.

Load on the rails to be drawn by the driving wheels, 14 tons.

Pressure of the boiler, - - - - 6 atmospheres.

The whole train, about - - - 119 tons.

The rate of motion, per hour, - - 15 kilometers.

Under a pressure of 7 to 8 atmospheres, the locomotive slid easily over the rails when the galvanic circuit was open; the movement ceased when it was closed, and began again when again open. To make the locomotive move in spite of the magnetism, a pressure of 9 atmospheres was required with a risk of bursting the boiler which was registered for six atmospheres. Under this pressure, the driving wheels moved in both cases, yet with an apparent difference when the wheels were magnetized.

The additional adhesion from magnetism was thus proved, although it was less than could have been obtained with a more convenient arrangement. In fact the particular process followed in this trial, did not retain the magnetization quite constant at the point of contact of the wheels; this magnetization diminished with the rotation, as shown in the following table, which gives the results of trials with a single wheel, from rest to a velocity of 18 kilometers an hour.

Turns per miuute.	Kil. per hour.	Pressure due to Magnetization.	Relation of *additional* pressure to the *ordinary* pressure on the rail.
0	0	639 kil.	12·8 to 10·6 p. c.
30	9	255	5·1 to 4·3 p. c.
60	18	165	3·3 to 2·7 p. c.

In this experiment the wheels did not rest on the rail as in ordinary conditions: by means of the grease-box reversed of each, they were fixed upon a framework for their support ; two wooden pulleys were arranged on the motor axle ; these pulleys, in connection with the power wheel of the work shop, were calculated so as to furnish the two velocities of rotation, registered in the table. The rail placed below each wheel was moveable at one of its extremities, around a bolt, and carried at the other, a box of zinc for receiving the weight necessary for detaching the rail from the wheel when it was suspended by the magnetising action ; a reservoir of water, divided into litres, was arranged so as to turn into each box the water necessary for breaking the connection.

Kowing the length of the rail, its weight, the same of the box of zinc, and the quantity of water required from the reservoir, we may, by a simple calculation, ascertain the amount sustained by the point of contact, and thence the pressure due to the magnetisation, either during rest or rotation.

In this way the table above has been obtained. The decrease observed during rotation was also exhibited in the following manner. The rail resting at its free extremity on a block of wood, and being separated from the wheel by an interval of 0·17 metre, a small magnetic declination needle placed at a distance of 0·75 metre from the rail, was moved along the the wheel in order to ascertain the points where its direction was perpendicular to the plane of the wheel.

When the wheel was at rest, the needle took a position vertical to the rails only when in a vertical plane passing by the axle, and consequently at the point of contact with the wheel. When on the contrary, the wheel was in motion, it was necessary to change the place of the needle, moving it backward (in relation to the direction of the movement of the wheel) in order to obtain the direction normal to the rails. This change of place amounted to 0·33 and 0·39 m. for velocities corresponding to rates of 18 and 36 kilometers to the hour.

These observations show that the resultant of the magnetic forces which passes by the centre of gravity of the helix, and consequently by the point of contact of the wheel when it is in repose, becomes displaced during the movement, and is no longer identical with the point of contact. This arises from two distinct causes. At the moment of entering the helix, the portion of the rim of the wheel under consideration experiences a first effect of magnetisation tending to impress upon it a polarity conformed to that part of the helix which is opposite to the point of contact. Reaching this point, it should be at its maximum power : but in presence of the contrary fluid of the superior part of the helix, its magnetism diminishes while it is rising and moving from the helix, and the fluid has changed its name when the rim has arrived at the

emergence. These contrary effects of magnetisation and demagnetisation, and subsequently of inversion of the fluid, might be made of use, if contrary to the fact, the rim was made of soft iron, having no coercitive force. Hence, at each revolution, the wheel is subject to double magnetic work, which is unequal, and must give to the resultant of the magnetic actions, a position of equilibrium different from that existing when the wheel is at rest.

At rest, the wheel does not differ from an ordinary electro-magnet; like it, it is divided into two parts magnetically distinct; the turns of its helix are parallel to the plane of the armature; the resultant of the magnetic actions developed by the helix is perpendicular to this plane, and passes by the centre of gravity of the helix. The position of the pole is then subordinate to that of the helix. If the former is displaced 0·33 meter it is only necessary to move the helix forward a corresponding quantity to remedy the displacement of the pole, which will be easily managed, if no other improvement is required.

One of the most important improvements consists in the possibility of bringing into simultaneous action the two magnetic poles, to profit by the increase of force that always takes place when both poles act together on an armature. The trial reported by me in this Journal,* evinces the importance of this condition.

The improvements which I have explained as regards the general principle, in the July number of this Journal, in my article on circular electro-magnets, aim principally towards,

1. Preventing the displacement of the poles.
2. Giving constancy to the magnetisation of the wheel.
3. Bringing both poles into concurrent action.

The concurrent action of both poles is made certain by the check described above, as well as by the more convenient electro-magnet which I have made known in the January number of this Journal, and which may be also of use as a check on railroads.

The researches which I have here described, constitute the first part of my experiments. It would have been difficult to have carried them thus far, if I had not found in one of the most distinguished engineers of France, a Mæcenas who appreciated at first sight the importance of my labors, and by a rare generosity enabled me to undertake these researches. M. Bazaine, in whose life many facts of the kind might be mentioned, needed not this new act of disinterestedness, that his love of progress should be known. He was among those who introduced railroads into France, and he gave the country its first great road, that from Strasbourg to Basle.

* Vol. xv, p. 104, Jan., 1853, and p. 380, May.

Art. XXXIV.—*On the Passivity of Nickel and Cobalt;* by M. J. Nicklès.

The singular property of iron of becoming less oxydisable in contact with fuming nitric acid, has engaged the attention of many chemists and physicists. Since its discovery by Keir, it has been examined from different points of view by Herschell, Faraday, Schönbein, Buff, de la Rive, Andrews, Mousson, Millon, Beetz, and Bollmann. The researches of these investigators have shown that iron may become passive not only in contact with fuming nitric acid; it acquires this property also on blueing it in the flame of a lamp, or on touching it with a plate of platinum, while it is plunged in nitric acid not fuming.

The same effect is produced when the iron is put in connection with the positive pole of a galvanic battery. As evidence of the modification which it undergoes under these circumstances, the iron does not precipitate sulphate of copper when it is used as the anode of a galvanic element; oxygen is disengaged around it, without attaching it; in contact with diluted nitric acid, it remains unaltered, but it becomes again active when after being taken from the acid, it is put into water.

Similar facts may be observed to a greater or less extent with nickel and cobalt drawn into wire. The wire of these metals used in the experiments was chemically pure; it was prepared by M. H. Sainte Claire Deville, by a process of heating of his invention,* who also analyzed it.

In fuming nitric acid, both of these metals acquire a passive state only of short duration; but the passivity becomes permanent when, after blueing them in the flame of an alcohol lamp or on a charcoal fire, they are plunged while hot into this acid, in which case, they act in every respect like passive iron, except that they are less negative than in nitric acid. They can however, communicate their passive state to active iron plunged in nitric acid not fuming, and so arrest the energetic action that is produced by the acid.

Platinum is always negative with respect to these three metals in the passive state, and either of these last is negative with respect to the same in the active state.

The preservation of iron against attack in sulphate of copper, observed by M. Schönbein, has not been obtained out of the galvanic current; in all my experiments, the passive iron becomes promptly covered by metallic iron.

I have also examined the electro-chemical relations of iron, nickel and cobalt in the active and passive states, in contact with different acids as well as a solution of potash in water. The negative character of passive iron is really very decided only in

* See this Journal, xv, 424.

nitric acid; in the other liquids used in the trials, positive electricity passes to the iron instead of proceeding from it. In the potash liquid, the reactions have been the same both for the active and passive metals, which seems to show that the passivity of these related metals is destroyed by this alkali; in fact, if after this immersion in potash, they are put in contact with nitric acid of density 1·34, they are found to have resumed the electro-chemical condition which belongs to the passive state and they are no longer attacked by the acid.

The following series exhibits the relations respectively of iron, nickel, and cobalt to the two states, commencing with the positive metal, and ending with the negative; the experiments were made with the different liquids mentioned in the table:

Liquids employed	Active Metals.	Passive Metals.
Fuming nitric acid.	+ . . . − .	+ Co, Ni, Fe, −
" " G = 1·34.	Fe, Co, Ni.	Co, Ni, Fe.
S̈ Ḣ	Co, Fe, Ni.	Ni, Co, Fe.
S̈ Ḣ, with 9Ḣ.	Fe, Ni, Co,	Fe, Co, Ni.
Potash solution.	Fe, Ni, Co.	Fe, Ni, Co.

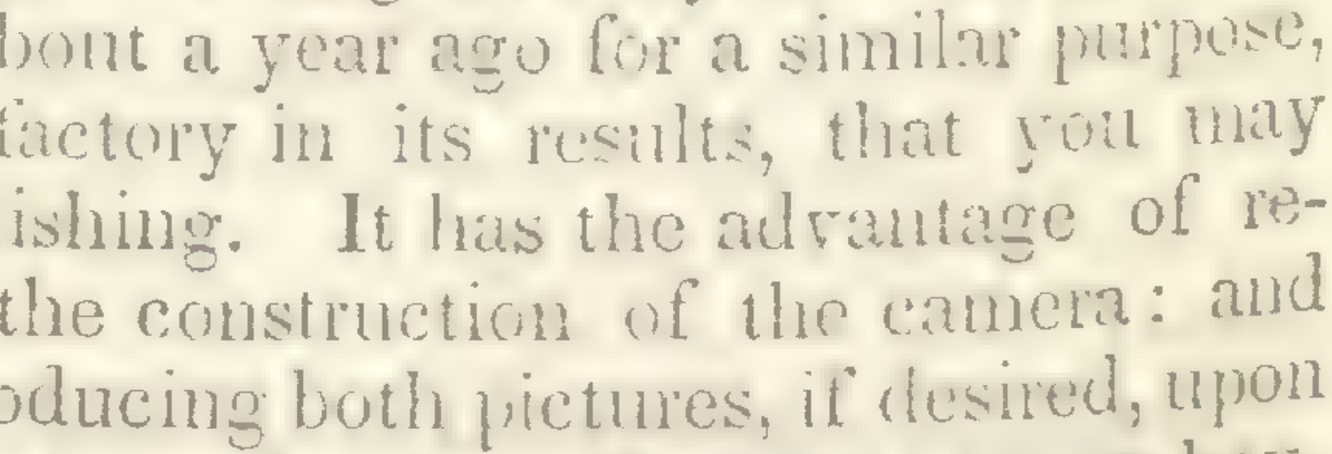
Palladium is equally susceptible to the passive state.

Art. XXXV.—*Method of taking Daguerreotype Pictures for the Stereoscope, simultaneously, upon the same plate, with an ordinary Camera*; by F. A. P. Barnard, Professor of Chemistry and Natural History, in the University of Alabama.

Prof. Dana.—In the September number of the Journal of Science, just published, I observe a mention of a method of taking photographic pictures for the stereoscope, the two pictures being taken simultaneously. This has brought to my mind an arrangement employed by myself about a year ago for a similar purpose, which is so simple and satisfactory in its results, that you may possibly think it worth publishing. It has the advantage of requiring no modification of the construction of the camera: and also the additional one of producing both pictures, if desired, upon one plate. This last result cannot be secured with a camera having two object-glasses, (without, at least, a very inconvenient arrangement of mirrors,) because, of the two pictures produced in such a camera upon one plate, the right hand one will be that which should belong to the left eye, and vice versa.

Fig. 1 is a plan of the arrangement which I have employed. C is the camera, P a central point in an object to be copied, and AM, AM, two small vertical plane

1.

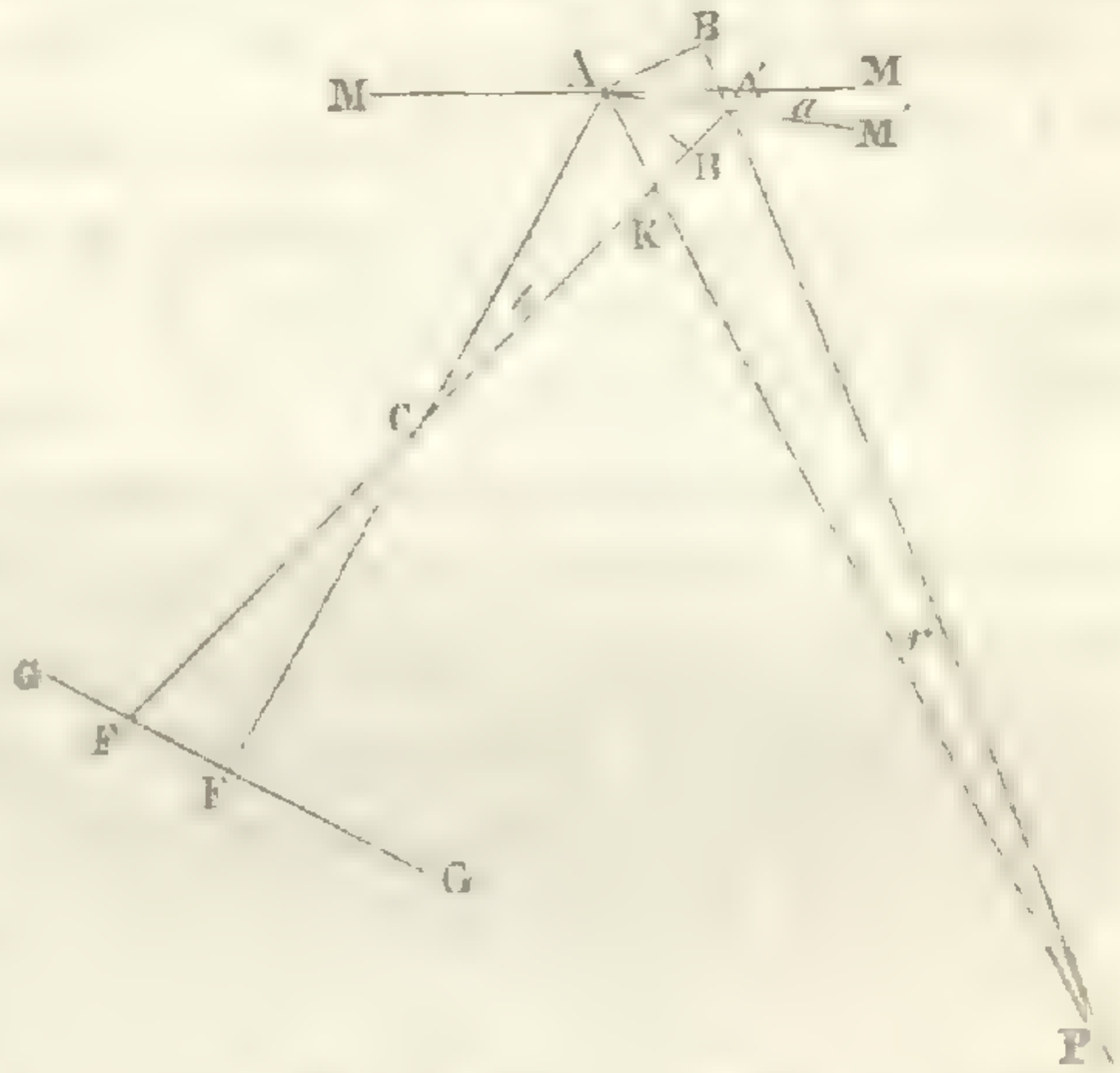


mirrors, moveable on a common vertical hinge at A. These mirrors are at first brought truly to the same plane, so that they give but one image of the object on the ground glass screen of the camera, at F. The camera is then adjusted so that, the image of P being single, the optical axis F'A may be directed truly toward the hinge A, and the image be formed truly in the middle of the screen, at F. Now supposing that it is desired to produce two pictures distant from each other (measuring from centre to centre) by a space $=n$, the two mirrors must be carefully moved on the hinge A to the positions AM′ and AM″, so that the images of P reflected by them shall pass from F to f, and from F to f', each of these distances being $\frac{1}{2}n$.

In order that the points of view under which these images will present P, may be so far different as to correspond to those of the two eyes in natural vision, the camera must be placed at a certain determinate distance from the mirrors. This will be easily ascertained without calculation by a person familiar with this process; but it may be found mathematically as follows:

Let AM, AM, fig. 2, be the two mirrors, and A the hinge. Then, the camera being supposed to be properly adjusted, AF will be the line of its axis, and also the direction of the ray PA after reflection, while the mirrors continue in one plane. Let AM′ be the position of one of the mirrors after its displacement. Then if C be the virtual centre of the arrangement of lenses, the image of P will be formed at F′ instead of at F, by means of the ray PA′ reflected through C to F′. GG′ the glass screen, will of course be perpendicular to the axis AF.

2.



Draw AB perpendicular to AP, and AB′ perpendicular to AF. Put the angular change of position of the mirror M′ (=angle MAM′)= α, the angle ACA′= δ, and the angle APA′= γ. Then in the triangle PAB, right-angled at A, angle B= $90° - \gamma$. It is easily seen that BAM= the original angle of incidence of PA. Represent this angle by I. Then,

$$\text{BAM} + \text{MAA}' = \text{BAA}' = \text{I} + \alpha$$

$$\text{Also, as above,} \quad \text{ABA}' = 90° - \gamma$$

Whence, in the triangle BAA′, the third angle, BA′A= $90° - \text{I} - \alpha + \gamma$.

Now, to obtain AA′ in terms of AB,

$$\sin \text{BA}'\text{A} : \sin \text{ABA}' :: \text{AB} : \text{AA}',$$

Or, putting $AB = a$

$$\sin(90^\circ - I - \alpha + \gamma) : \sin(90^\circ - \gamma) :: a : \frac{a\cos\gamma}{\cos(I + \alpha - \gamma)}.$$

Again, in the triangle $B'AA'$,

$$\text{Angle } AB'A', = 90^\circ + \theta.$$

$$\text{And, } AA'B' (= AA'B) = 90^\circ - I - \alpha + \gamma.$$

Whence $\sin AB'A' : \sin AA'B' :: AA' : AB'$.

$$\text{Or} \quad \sin(90^\circ + \theta) : \sin(90^\circ - I - \alpha + \gamma) : \frac{a\cos\gamma}{\cos(I + \alpha - \gamma)} : AB'$$

$$\text{And } AB' = \frac{a\cos\gamma\cos(I + \alpha - \gamma)}{\cos\theta\cos(I + \alpha - \gamma)} = \frac{a\cos\gamma}{\cos\theta}.$$

Now AB' is parallel to GG: hence,

$$FF' : AB' :: FC : CA,$$

which last term is the distance (measured from the virtual centre of the objective) at which the camera must be placed from the point A.

In this proportion, FF' is arbitrarily fixed, and will be from 1 to $1\frac{1}{4}$ inches, FC is the focal distance of the camera, when the image of P is distinct on the screen, and AB' is determinable by the foregoing formula.

In that formula, α is one half the distance between the eyes ($1\frac{1}{4}$ inches on an average), θ is directly determinable in the right angled triangle CFF', and γ is in like manner to be obtained from the right angled triangle PAB, the distance, AP, of the object from A, being ascertained by measurement.

The mirrors ought to be such as are prepared for photographic purposes;—that is to say, they should be of the best glass, and have their surfaces perfectly parallel, or else they should be of metal. Nevertheless I have succeeded very well with good plate looking-glass. I send you a specimen taken with such, that you may compare it with specimens otherwise prepared. The imperfections of the glass will be less sensible, in proportion as the incidence approaches perpendicularly; but there is an obvious limit to this.

The photographs which I have prepared in this way are not surpassed by any others I have tried. I am accustomed to adjust them on the plate at a distance from each other somewhat less than that of the eyes (say between 2 and $2\frac{1}{4}$ inches from centre to centre). I employ no optical artifice, (i. e. interposed prisms, or lenses excentric to the eyes,) to superpose them; but looking through the centres of the lenses, the superposition takes place naturally and easily. If the pictures are rather large, however, they must be more widely separated, and then some optical expedient must be employed to produce deflection and aid the eye.

Tuscaloosa, Sept. 6, 1853.

P. S.—In every daguerreotype for the stereoscope which I have seen (as purchased from the opticians) the relief is grossly exaggerated. You will not find such the case with this. The error of the manufacturers has been to make the points of view (in taking the photographs) too widely different.

ART. XXXVI.—*Theoretic Determination of the Expenditure of Heat in the Hot-air Engine: Supplementary Article;* by FREDERICK A. P. BARNARD, Professor of Chemistry and Natural History, in the University of Alabama.

A NEAT and direct expression may be obtained, for the total consumption of heat in the air engine, in terms of the numerical ratio between the cylinders, the fractional part of the stroke of the piston before cut-off, and constants. We must include in this, however, a loss from a source not considered in the article published in the last number of this Journal; viz., that which is occasioned by the expansion of the air at the moment of final escape. It is evident that if, at the close of the stroke, the air in the working cylinder has a higher elasticity than that of the atmosphere, it will expand as it emerges, until an equilibrium is established, and a portion of its heat will disappear.* This is provided for in the following. We will employ, as before,

T, to represent the working temperature.
θ " " that of the weather.
θ' " " that of the air after compression.
θ'' " " that of the same at the moment of escape.
Θ " " the reciprocal of the coëfficient of expansion, (i. e. 491° F.)

The other symbols employed in the former article, will be similarly employed here.

It has been shown that, of the heat received from the furnace, there is directly converted into expansive power an amount equal to $(T-\theta')(\gamma-1)$. There is also lost by expansion, in the act of escaping, the additional amount of $(T-\theta'')$. And there is a compensation, in consequence of cooling under the constant atmospheric pressure, equal to $(\theta''-\theta')(\gamma-1)$. These expressions united, are reducible to

$$(T-\theta'')\gamma,$$

which is a general expression for the total expenditure.

But θ'' is not a constant. While T and θ remain the same, it will be a function of l and m, the length of the stroke before cut-off, and the ratio of the cylinders to each other in cross section. By Poisson's first equation,

$$p'=p\left(\frac{\varrho'}{\varrho}\right)^{\gamma},$$

* To the truth, in every particular, of the paradox introduced by way of illustration, in the commencement of the former article, it is evidently necessary that the air which is supposed to escape after being heated without previous compression, should be prevented from expanding as it escapes;—as, for instance, by being returned directly to the supply cylinder. Practically, however, it would be impossible for the regenerator to abstract from this air all the heat it had received; but if it could, the result would be as there stated.

in which p' is the working pressure, ϱ' the density of the compressed air, p the atmospheric pressure, and ϱ the density of the atmosphere, assumed $=1$. Now, if ϱ'' represent the density of the air in the working cylinder at the moment of cut-off, and ϱ''' the density at that of final escape, we shall have, by virtue of the same equation, for the *pressure at escape* (represented by p'')

$$p''=p'\left(\frac{\varrho'''}{\varrho''}\right)^{\gamma}.$$

In this, if we substitute the foregoing value of p', we obtain

$$p''=p\left(\frac{\varrho'}{\varrho}\right)^{\gamma}\left(\frac{\varrho'''}{\varrho''}\right)^{\gamma}$$

But, as in the nature of things, p'' must equal p, this equation becomes,

$$1=\left(\frac{\varrho'}{\varrho}\right)^{\gamma}\left(\frac{\varrho'''}{\varrho''}\right)^{\gamma}, \text{ or } \left(\frac{\varrho}{\varrho'}\right)^{\gamma}=\left(\frac{\varrho'''}{\varrho''}\right)^{\gamma}.$$

Now, by Poisson's second equation,

$$\theta''=(\Theta+\mathrm{T})\left(\frac{\varrho'''}{\varrho''}\right)^{\gamma-1}-\Theta.$$

Whence, also,

$$\theta''=(\Theta+\mathrm{T})\left(\frac{\varrho}{\varrho'}\right)^{\gamma-1}-\Theta,$$

And we have no occasion to determine ϱ''' and ϱ''.

For ϱ' we proceed thus. In the last number of the Journal we have these two expressions.

$$n=\left(\frac{\mathrm{T}+\theta}{\theta+\theta}\right)^{\frac{1}{\gamma}}\left(\frac{l}{m}\right)^{\frac{\gamma-1}{\gamma}}, \text{ and } \varrho'=\frac{mn}{l}, \text{ or } \frac{1}{\varrho'}\left(=\frac{\varrho}{\varrho'}\right)=\frac{l}{mn}.$$

Substituting the value of n in the last expression, we obtain, after reduction,

$$\frac{\varrho}{\varrho'}=\left(\frac{l}{m}\left(\frac{\Theta+\theta}{\Theta+\mathrm{T}}\right)\right)^{\frac{1}{\gamma}}.$$

And by substituting again in the preceding formula, we have finally,

$$\theta''=(\Theta+\mathrm{T})\left(\frac{l}{m}\left(\frac{\Theta+\theta}{\Theta+\mathrm{T}}\right)\right)^{\frac{\gamma-1}{\gamma}}-\Theta$$

Or, $$\theta''=\left[\left(\frac{l}{m}(\Theta+\theta)\right)^{\gamma-1}\left(\Theta+\mathrm{T}\right)\right]^{\frac{1}{\gamma}}-\Theta.$$

As the factors $(\Theta+\theta)^{\frac{\gamma-1}{\gamma}}$, and $(\Theta+\mathrm{T})^{\frac{1}{\gamma}}$, may be regarded as constant, we may represent their product by a single symbol, as N, which being substituted will simplify the expression thus:

$$\theta''=\mathrm{N}\left(\frac{l}{m}\right)^{\frac{\gamma-1}{\gamma}}-\Theta.$$

Whence for the total consumption,

$$(\mathrm{T}-\theta'')\gamma=(\mathrm{T}+\Theta-\mathrm{N}\left(\frac{l}{m}\right)^{\frac{\gamma-1}{\gamma}})\gamma.$$

Since we have all along regarded T as equal to 450°, Θ to 491°, and θ to 60°, $\mathrm{T}+\theta$ will be $=941°$, and $\mathrm{N}=791°\cdot663$. Hence finally, while these suppositions remain,

$$(\mathrm{T}-\theta'')\gamma=(941°-791°\cdot633\left(\frac{l}{m}\right)^{\frac{\gamma-1}{\gamma}})\gamma.$$

From this formula, making $\gamma=1\cdot36$, as before, we shall have, for the case of equal supply and working cylinders,

$$186\cdot55\,\mathrm{MK_v}=137\cdot17\,\mathrm{MK_p}=32\cdot59\,\mathrm{MK_w},$$

which is a larger result than was obtained in the former article, while the effect of final expansion was disregarded. Supposing, as before, that the cylinder will contain 70 lbs. of air, the entire consumption of heat would be sufficient to raise a pound of water $70\times32°\cdot59=2281°$, or to convert nearly two pounds of water into steam at 212°. The power of this steam, computed as in the former article, would be sufficient to raise 115000 lbs. one foot, or 19100 through the six foot stroke. But, as we have seen that the air engine will raise, on the present supposition, 56400 lbs. six feet with the same expenditure, the expansion is in favor of air in the ratio 1 : 2·95.

Supposing the cut-off at $\frac{2}{3}$, the mean pressure will rise to 116600 lbs., being an increase of more than 100 per cent., while the expenditure of heat will be increased but about 60 per cent. The steam which this heat would generate, would raise 30500 lbs. through the six-foot stroke, showing an advantage in favor of air, as 1 : 3·80. But if the steam is allowed to expand to the same extent as the air, the advantage will be reduced to the ratio, 1 : 2·80.

A supply cylinder equal to the working cylinder, however, is too large for economy. This is a consequence of the loss of heat by expansion, in escaping, spoken of in the commencement of this article; and it could not be true if the regenerators were capable of arresting the heat remaining unexpended at the close of the stroke, to the extent anticipated by the inventor. Taking the proportions of Ericsson's cylinders, we shall have, for a $\frac{2}{3}$ cut-off, 186 units of heat consumed to every unit-weight or pound of air. But as the air is now but $\frac{2}{3}$ of what was before supposed, our multiplier will now be 47 instead of 70. On completing the calculation, we find that heat enough will be expended, to raise, by means of steam at 212°, 12830 lbs. six feet. But the air engine, in this case, will raise 77660 lbs.,* to the same height with the same expenditure of heat; so that, here, the advantage is in favor

* Stated incorrectly seventy-*four* thousand pounds, in the former article.

of air in the ratio, 1 : 6·05. If again, we allow an equal expansion to steam, the advantage will be reduced to the ratio 1 : 4·40.

In all these computations, as in the former article, we have considered the value of the *co-efficient of capacity* for air (or γ) to be only 1·36. But there can now be no doubt that this ought to be put =1·40, or 1·41. Mr. Rankine (Lond. and Ed. Phil. Mag., June, 1853) adopts 1·4094, which is employed in the computations that follow. The effect of the enlargement of this number, is to diminish somewhat the calculated power of the air engine, in every case.

For the sake of making apparent, in a single view, the effect of variations in the proportions of the cylinders, and of different positions of the cut-off, the following table has been prepared, exhibiting a large variety of suppositions. The little probability which seems now to exist, that any further attempt will be made to apply the invention in practice, renders the calculations rather curious perhaps than useful ; but they may serve to throw some light upon certain questions which have been topics of discussion with different writers on this subject.

In this table, the symbols l and m stand as in the former article, for the length of the stroke before the cut-off (the entire stroke being unity), and the numerical ratio in cross section between the cylinders (that of the working cylinder being unity). In the column headed "heat expended," are given the numbers of units (or degrees F.) which the total theoretic expenditure would be capable of imparting to one unit of weight (or pound) of water. The column headed R, shows the theoretic ratio of advantage in favor of air, as compared with the steam which the heat expended would produce at 212°, the steam being supposed to work without expansion. The column R′, shows a similar ratio, on supposition that the steam expands as much as the air. Since these expansions are very variable, the numbers in this column are a less eligible criterion by which to judge of the relative theoretic economy of air and steam engines, than those of the column R. But as steam is often worked with much larger expansion than any that air admits of, an additional column is introduced, headed R″, which shows the effect of heated air as compared with that of the steam generated by the same heat, and expanded to three times its original bulk.

All the powers in this table are computed by means of the formula, p. 248, of the last number of this Journal,* and on the sup-

* In this formula as there printed there occurs an error. In the last term within parenthesis, the factor $l^{\gamma-1}$ should be $l^{\frac{\gamma-1}{\gamma}}$.

Also, in the particular formula, top of the following page, the numerator of the first fractional term should read $\lambda\mu^{\gamma}(\lambda^{\gamma-1}-1)$ instead of $\mu^{\gamma}(\lambda^{\gamma}-1)$. These errors are discoverable by following out the steps of the processes which precede them;

position that the surface of the working piston is 22100 square inches, the stroke six feet, and the number of revolutions, ten.

Aggregate horse-power of air engines, with the corresponding expenditure of heat, and a comparison with steam.

m	*l*	H. P.	Heat expended.	R.	R′.	R″.
1	1	197	2486°	1 : 2·60	1 : 2·60	1 : 1·30
·85	·85	**279**	**2113**	**1 : 4·33**	**1 : 3·73**	**1 : 2·16**
·80	·80	290	1989	1 : 4·65	1 : 3·84	1 : 2·32
·7646	·7646*	292	1900	1 : 5·05	1 : 4·00	1 : 2·52
·75	·75	**291**	**1864**	**1 : 5·23**	**1 : 4·12**	**1 : 2·61**
·70	·70	**284**	**1740**	**1 : 5·53**	**1 : 3·99**	**1 : 2·76**
⅔	⅔	**273**	**1657**	**1 : 5·41**	**1 : 3·95**	**1 : 2·70**
·65	·65	**268**	**1616**	**1 : 5·40**	**1 : 3·87**	**1 : 2·70**
·60	·60	**241**	**1492**	**1 : 5·31**	**1 : 3·63**	**1 : 2·65**
1	·85	303	3094	1 : 3·20	1 : 2·77	1 : 1·60
1	·80	**333**	**3312**	**1 : 3·29**	**1 : 2·72**	**1 : 1·64**
1	·75	**360**	**3542**	**1 : 3·34**	**1 : 2·52**	**1 : 1·67**
1	·70	384	3783	1 : 3·32	1 : 2·50	1 : 1·66
1	⅔	**398**	**3949**	**1 : 3 29**	**1 : 2·49**	**1 : 1·64**
1	·65	403	4036	1 : 3·26	1 : 2·33	1 : 1·63
1	·60	**415**	**4302**	**1 : 3·25**	**1 : 2·23**	**1 : 1·62**
·85	·80	**308**	**2309**	**1 : 4·37**	**1 : 3·61**	**1 : 2·18**
·85	·75	**336**	**2512**	**1 : 4·38**	**1 : 3·45**	**1 : 2·19**
·85	·70	**359**	**2727**	**1 : 4·31**	**1 : 3·24**	**1 : 2·15**
·85	⅔	**374**	**2875**	**1 : 4·26**	**1 : 3·11**	**1 : 2·13**
·85	·65	381	2932	1 : 4·14	1 : 2·99	1 : 2·07
·85	·60	**397**	**3190**	**1 : 4·08**	**1 : 2·79**	**1 : 2·04**
·80	·75	319	2183	1 : 4·73	1 : 3·75	1 : 2·36
·80	·70	**340**	**2390**	**1 : 4·68**	**1 : 3·52**	**1 : 2·34**
·80	⅔	356	2530	1 : 4·61	1 : 3·36	1 : 2·30
·80	·65	362	2606	1 : 4·59	1 : 3·27	1 : 2·29
·80	·60	378	2833	1 : 4·37	1 : 2·19	1 : 2 18
·75	·70	**315**	**2047**	**1 : 5·00**	**1 : 3·77**	**1 : 2·50**
·75	⅔	331	2197	1 : 4·90	1 : 3·59	1 : 2·45
·75	·65	340	2267	1 : 4·88	1 : 3·50	1 : 2·44
·75	·60	**355**	**2484**	**1 : 4·67**	**1 : 3·20**	**1 : 2·33**
·70	⅔	299	1870	1 : 5·23	1 : 3·80	1 : 2·61
·70	·65	306	1936	1 : 5·17	1 : 3·67	1 : 2·58
·70	·60	328	2144	1 : 5·01	1 : 3·43	1 : 2·50
⅔	·75	235	1349	1 : 5·67	1 : 4·61	1 : 2·83
⅔	·70	259	1532	1 : 5·53	1 : 4·15	1 : 2·76
⅔	·65	281	1722	1 : 5·32	1 : 3·84	1 : 2·66
⅔	·60	**301**	**1922**	**1 : 5·14**	**1 : 3·52**	**1 : 2·57**
·65	·60	287	1813	1 : 5·18	1 : 3 55	1 : 2·59

The column R″ shows that there is still a large theoretic balance in favor of air, as respects economy of heat, even when steam is worked with pretty large expansion. Moreover, the ad-

but as these processes **are not all simple, the misprints may not be detected without** notice of their existence.

In the numerical value of the maximum just below, ·71 should be ·76.

There are a few errors in the text which somewhat obscure the meaning. In line 7, p. 235, "undeniable" **should be undesirable. In p. 225,** line 22. "properties" should be proportions. In p. 245, last line but one, "iraction" should be function.

* In the first division of the table, *l* is made equal to *m* for various values. In this case the maximum power is obtained with $l = m = ·7646$.

vantage is somewhat greater than it appears in the table, since this column is computed by regarding the expansion of steam as conforming to the law of Mariotte.

There are large drawbacks, however, which have not been considered. In the first place, the regenerators cannot possibly (as our supposition has presumed) abstract from the escaping air all the heat down to the temperature θ'. There must also be great loss by radiation and conduction. Much heat is carried off by the leakage of the heated air, and finally the escape of heat through the smoke pipes cannot but be largely greater than occurs in heating water in boilers.

Capt. Ericsson allows a loss of 30° from the first of the causes above named. This would amount to from 12 to 25 per cent. upon the total theoretic consumption. In working with $l = m$, it would be 20 per cent.; and this alone would make a considerable reduction upon the favorable ratios in the table.

It will be seen, by inspection, that if power is sought without regard to economy, large supply cylinders are to be preferred. The construction proposed by the present writer in the last number of this Journal, renders the use of such cylinders practicable, though it would not be so on Ericsson's plan.

If economy is sought at the expense of power, cylinders from ·60 to $\frac{2}{3}$ in cross section, furnish the best results. In this point of view, Capt. Ericsson's proportions are well chosen. It is also apparent that the cut-off which produces the most economical results is at ·75 or thereabouts, whatever be the ratio between the cylinders.

But, on all accounts, it is evident at a glance, that the supply cylinders between ·70 and ·80 in section (probably about ·75 in preference to any other) are most eligible. Very little is lost by their use, in point of economy, while there is secured a very great gain of power.

But here probably we encounter the great and it is to be apprehended the inseparable obstacle, in the way of the success of the hot-air engine viz., the practical difficulty of heating the great mass of air with sufficient rapidity. Suppose we make all reasonable allowances for the effect of friction, leakage, and clearance of cylinder, it is not possible after all to bring down the power so low as the experiment with the "Ericsson" ship showed it in fact to be.

Capt. Ericsson, for instance, says that a pressure of half a pound to the inch, is sufficient to overcome resistances. At 12 pounds above the atmosphere in the reservoir (what he aimed at), this would constitute a charge of about 15 per cent. upon the power; for with 12 pounds actual pressure, but about 3·4 lbs. pressure over resistances is obtained. For leakage we have no reliable data upon which to form an estimate; but we know that in the

ship, the leakage was actually large, and it will probably be not far from the truth to put this at 15 per cent. more. We thus obtain a reduction of thirty per cent. in all, while the engines fell as far as fifty per cent. below their aggregate theoretic power.

The remaining deficiency can hardly be accounted for, but by supposing that the air *could not be heated* by furnaces and regenerators both together, to a sufficient degree and with sufficient rapidity to maintain the theoretic pressure, and the assumed velocity of piston. This explains the statements made by reporters present on the trial trip, that the temperature of the working cylinder did not rise above 410°, and also Capt. Ericsson's repeated assertions that he could not carry more than 8 pounds of pressure. And this may satisfactorily explain the published statement which has remained for two months uncontradicted, that the original plan of heating the air has been entirely abandoned.

The results to which this investigation has brought us, are less encouraging than were anticipated, or than, in the beginning we even desired to find them. We are compelled to look, at present, much less hopefully upon this invention than we have been disposed to do heretofore; so much less so, as to apprehend that it can never come into successful use as a motive power.

Univ. of Alabama, Aug. 30, 1853.

Art. XXXVII.—*On the Consolidation of Coral Formations;* by James D. Dana.

At the Cleveland meeting of the American Association for the Advancement of Science, in August last, Prof. Horsford read a labored reply to the writer's criticisms* of his views, on the consolidation of coral limestone. This paper by Prof. Horsford, has appeared in several daily newspapers, and has thus had a wide circulation. Deeming the public papers no proper place for scientific controversy, either for attacks or replies, and knowing that an author may not hold himself responsible for the accuracy of articles thus published, the writer had intended to take no notice of the arguments of Prof. Horsford, until they had appeared elsewhere. But on finding evidence in the date of the reading of the paper at Cleveland, (Friday, July 29,) and its appearance in the Boston Traveller, (Monday, Aug. 1,) that the article was in type before it was read, and that therefore, it may have been set up long enough before the meeting of the Association to allow of Prof. Horsford's correcting the proofs,† there appeared to be suffi-

* This Journal, [2] xiv, 410.

† We might give further evidence on the above point, but deem it unnecessary. The paper occupies 5½ columns in the Traveller, each about two feet long.

We understand that Prof. Horsford considers us as having refused the publication of any reply from him. We wrote him that we should submit his reply, when sent

cient reason for considering Prof. Horsford responsible for what he had thus published, and for subjecting his statements to a brief notice in this place. I was not present at the meeting of the Association where the paper was read.

I propose therefore, to touch briefly upon some of the more obvious errors, misapprehensions, or inadvertencies, into which Prof. Horsford appears to have fallen.

I. Prof. Horsford's investigations were made principally upon what he calls the "crust-rock," one of the two kinds of coral formations which he mentions; and this might be supposed from his descriptions to be a common form of the coral reef rock. In fact, it is an uncommon variety. I found nothing like it in my explorations among the Pacific reefs and islands. The ordinary submerged reef rock, the prevailing rock wherever there are reef-regions, has no resemblance whatever to the "crust-rock," and is distinct also from his "oolitic" rock. It is sufficient to account for the misapprehension which Prof. Horsford appears to be under respecting reef rocks, to state that he has never seen a coral reef.

II. Some examples of a thin calcareous crust, are described by the writer as occurring in the Sandwich Islands. Prof. Horsford errs in regarding these as examples of his "crust-rock". The author has described them as a surface formation upon elevated hills of coral sand rock; that is, as mere surface crusts *upon the "oolitic" variety* of Prof. Horsford; it is of much more modern origin than the rock itself, and not one of the two prevailing varieties of reef rocks, any more than a stalagmite is an example of the rock which it encrusts.

III. Prof. Horsford supposes erroneously that the explanation of the origin of this crust which I give, has been applied by me to the West India "crust-rock." Not having seen that rock in place, I have offered nothing upon its origin or consolidation.

IV. Prof. Horsford proceeds in his theory upon the supposition that the coral sands of seashores and submerged coral deposits of reef grounds, contain a large per-centage of animal matter. This conclusion, he has not sustained by an examination of these materials from various regions: he is satisfied after an examination simply of some specimens of his "crust-rock;" and proceeds at once to theorise for all coral formations: for if he does not say in so many words that his theory is intended for coral rocks generally, the manner in which he has replied to my objections, and the use

us, to Dr. Gibbs, our collaborator in charge of chemistry and physics, and that if in his opinion its chemistry and statements of facts were correct, it would be published; also, that if his former paper had been thus submitted, it would not have appeared in this Journal, on the ground of its incorrect chemical principles. Had his recent reply been sent us, we should probably have saved Prof. Horsford the publication of some of its errors.

he makes of the facts I have published, show that he intends for it this universal application.

V. In the analyses of the "crust-rock" in Prof. Horsford's former paper, he claimed to have found in one case, 20 per cent. of animal matter. In the recent paper, another analysis is given in which there are but 1·47 per cent., (no more than was found by Prof. Silliman, Jr. in some of the bleached corals,) and the difference is accounted for, on the ground that the "stage of decomposition of the organic matter was further advanced" than in the specimens before examined. This recent analysis is therefore no confirmation of the former results: moreover, the discrepancies in the earlier analyses, pointed out in my former paper, have shown them to be not altogether trustworthy, and Prof. Horsford now admits that the object of the first analysis was qualitative rather than quantitative. The foundation for the theory proposed, is therefore based on a scanty supply of imperfectly ascertained data.

VI. In discussing the chemical objections to his theory, he comes at last to the point on which the whole turns,—the formation of hydrate of lime,—and thus observes:

"Prof. Dana proceeds: But suppose the uncombined ammonia to be formed during the decomposition, will this ammonia precipitate the hydrate of lime from the solution of the sulphate? It is perhaps sufficient to say in regard to this statement of Prof. Dana's, that it was written in entire misapprehension. It is due to myself however to add, that I have never uttered anything of the kind, and that in an earlier allusion to the view, the learned author correctly states what I did say. He says in repeating my views. 'The ammonia resulting from the nitrogen, carries off the sulphuric acid [of the sulphate of lime]* as sulphate of ammonia, and leaves the lime as a SOLUBLE *hydrate*.'"

The small capitals and italics are Prof. Horsford's.

The assertion, "I have never uttered anything of the kind," is forcible and apparently decisive.

The verbal difference between the statement alleged to be erroneous, and that acknowledged to be correct, consists in substituting *precipitate* for separate, and in omitting the word *soluble*.

Judging from the peculiar stress laid upon the word soluble by the use of capitals, it might be supposed that Prof. Horsford believed in a SOLUBLE hydrate, as distinct from another which was *insoluble*.

But chemists know of but one, and that takes 778 parts of water, at 60° F. (according to Dalton) to dissolve *one* part, or it is about *one half* as soluble as sulphate of lime or gypsum:† in pro-

* Prof. Horsford in his former paper, uses the words, "The nitrogen going over into the form of ammonia at a later period, decomposed the sulphate of lime, forming sulphate of ammonia and soluble hydrate of lime." We therefore add, "of the sulphate of lime," to make the statement complete.

† According to Bucholz, gypsum dissolves in 460 parts of water, either hot or cold, according to Giese, in 380 parts of cold and 388 parts of boiling water.—*Gmel. Chem.* iii, 202.

portions larger than this, it would be *precipitated* whenever *separated.* The two statements would therefore seem to a chemist to be very much of a kind, if not identical,—unless it is meant that more than *one* part of the hydrate to 778 of water would never be separated.

We pass to the chemistry of the passage which is the important point in the whole discussion,—for if false, the theory proves to be no better in its principles, than in its alleged facts.

Now it is well known that *ammonia will neither separate, nor precipitate, soluble or insoluble hydrate of lime, by action on the dissolved sulphate;* on the contrary, sulphate of ammonia is readily decomposed by a salt of lime, or by its hydrate. What avails then the long array of facts and arguments with which Prof. Horsford fills up his paper? Much might be brought forward on other parts of his chemical discussions, but as the keystone of his theory is gone, it would be a waste of words.*

VII. Prof. Horsford repeats from his former paper another mode of consolidation, viz., "The deposition of finely powdered carbonate of lime, with mucilaginous matter filling up the interstices between the grains of rock, and serving to increase the cohesion." This idea of making rocks by sticking the particles together with mucilage, (or with glue, as is implied in another place,) is quite original with Prof. Horsford. It needs no discussion.

VIII. After going over, with many details, the prominent points in the theory of consolidation proposed by him, Prof. Horsford presents another view which was barely intimated in his former paper, and which falls in with the theory that I had been led to adopt.

Before remarking upon it, I would state here that I have myself brought forward no *original* theory on this subject, but instead, have only appealed to a principle more or less fully received; —that of consolidation through the carbonate of lime dissolved in the carbonated waters which penetrate the deposited coral mud or sand. The beach sands and the drift heaps formed by the winds,—or in a word, all accumulations above low tide level,—are alternately wet and dry, under the action of the sea, and also the occasional rains. The rains are known to contain some carbonic acid, and the sea water also has been found to include a small proportion, so as to be able to dissolve some carbonate of lime, and, in time, produce the consolidation. With reference to submerged deposits, the same principle was supposed to operate; but as there

* Prof. Horsford insists in his article upon a certain order of decomposition, which is necessary to his theory; sulphuretted hydrogen being an early step, and ammonia or an ammoniacal salt the later. Facts in nature are the reverse of this. Moreover, he supposes the gas from animal decomposition, often called sulphuretted hydrogen from its smell, to be actually this gas or mainly so and uncombined, which again in many cases at least is not true.

is no *drying* in the process, it was suggested with hesitation that there might be a chemical action under the influence of the magnesian salts of the ocean, leading to a double carbonate of lime and magnesia, that is, a *dolomisation*,—Haidinger and von Morlot having shown that such a chemical change may be produced, at least under the influence of heat, and B. Silliman, Jr., having found a specimen of reef-rock to be a magnesian carbonate of lime.* The author has acknowledged that the subject required further investigation. It is possible that the superincumbent pressure may be one agency in promoting consolidation in the submerged deposits. It is altogether probable, that the process of animal decomposition going on within these beds, tends to promote, through the play of molecular forces thus set in action, (a kind of catalytic or "presence" influence,) the solidification of the mass by the crystallization of the carbonate of lime in solution,—a play of forces of one kind inducing the molecular action resulting in cohesion; and the same circumstances or condition would be particularly favorable for chemical changes, like that of dolomisation.

Prof. Horsford deserting in part, his favorite theory, here takes the old ground that consolidation may result through the carbonic acid in the permeating waters, and adds the suggestion that the *carbonic* acid might be derived from the decomposition of the animal matter within the coral mud,—which appears to be a sensible idea.

IX. In discussing this last-mentioned point, he says: "The slowly evolved carbonic acid would give to the surrounding pulverulent carbonate of lime, if not perfect solution, a degree of mobility which would permit the larger grains of carbonate of lime to attract it to themselves, and thus yield a kind of cement;" and again, "The carbonic acid would give mobility to the carbonate of lime, which would take on, according to the perfection of the solution, more or less of crystalline form." We confess we do not understand this "mobility." Infusorial mobility is out of the question; and what else shall we suppose was intended? The developed carbonic acid might shove the particles first one way, and then another, but this is not a consolidating process. If by *mobility* it is meant, that the waters thus carbonated would dissolve some of the carbonate of lime, and so give the particles mobility, and thereby promote consolidation, it is the old idea, though strangely expressed. If he means (seemingly he does not) that the process of decomposition is one promotive of consolidation, by a sort of catalytic influence, as above remarked, it might have been more distinctly explained.

* Dana's Exp. Exp. Geol. Report, p. 153

X. The absence of carbonic acid from sea-waters is a point which Prof. Horsford endeavors to prove by reference to several analyses. But is it true that carbonic acid is evolved as he allows, from the decomposition of animal matter in the mud or sands, forming the bottom of coral-reef regions, and yet that none escapes, so as to be found in the waters of these regions? It is obviously impossible.

Many analyses have actually found the carbonic acid or carbonate of lime. To meet the case fully, the analyses should be made of waters from reef regions, and not of those from the open sea. But Darondeau and Henry have found carbonic acid even in the air dissolved in various sea waters at different depths; and as their results are of some general interest, we cite the following table from the *Annales de Chemie et de Physique*, lxix, 103. The latitudes and longitudes are reckoned from Paris.

Time collected.	Lat.	Long.	Depth.	Density at 0° & 16° C.	Gas in 100 parts of water, at 0° C., & 760 mm. pressure.	100 parts of gas.		
						Oxyg.	Nitrogen	Carb. acid
Aug. 30, '36	11° 8′ N.	108° 50′ W	*Surface*	1·02594	2·09	6·16	83·33	10·51 (?)
"	"	"	70 *fath.*	1·02702	2·23	10·09	71·05	18·06
Mar. 19, '37	11° 43′ N	87° 18′ E.	*Surface*	1·02545	1·98	5·53	80·50	13·97
"	"	"	200 *fath.*	1·02663	3 04	3·29	38·56	58·15
May 10, '37	18° 0′ N.	85° 32′ E.	*Surface*	1·03611	1·91	6·34	80·34	13·32
"	"	"	300 *fath.*	1·02586	2·43	5·72	64·15	30·13
July 31, '37	21° 5′ S.	52° 0′ E.	*Surface*	1·02577	1·95	9·84	77·70	12·16
"	"	"	450 *fath.*	1·02739	2·75	9·85	53·23	31·92
Aug. 24, '37	30° 40′ S.	11° 47′ E.	400 *fath.*	1·02708	2·04	4·17	67·01	28·82

XI. Prof. Horsford in his former paper, attributes the coral mud of coral islands "in part," (I did not intentionally suppress this qualifying expression in my citation of his views,) to "the stone plants which flourish in the waters within the reef, and which admit of ready reduction to extreme fineness." In mentioning my objection to this view, he says:—"It is unfortunate that we find the author (Prof. Dana) elsewhere remarking: 'The Nullipores, properly calcareous vegetation, (stone plants,) flourish best along the line of breakers and form *thick accumulations upon the reefs*.'"

There are two misapprehensions here. First, Nullipores, and especially those that flourish in the breakers, are generally *less fragile* than corals themselves, being in solid calcareous branching forms, or incrustations, and always without cells. Secondly, the accumulations alluded to in the quotation from my Report, are absolutely solid massive limestone, and *not deposited grains or mud*, and they arise from successive growths over one another of these incrusting stone-plants.

Prof. Agassiz found in the West Indies, large accumulations of fragments of tender calcareous Algæ; and these Prof. Horsford evidently had in mind: but a calcareous mud is almost as readily made by the moving waters out of the fragments of coral as of these Algæ.

XII. To the principle, abundantly exemplified, that on shores where the waves break heavily, beds of pebbles or sand are produced, since the waters convey off the finer particles, and leave only the coarser; and on those where the motion of the waters is gentle, trituration produces a mud more or less fine, because the triturated material is not only ground up fine, but is deposited together where it is ground up; Prof. Horsford observes, giving to the theory a rule-of-three form, which is entirely his own: "As an application of the theory, that the less the agitation the finer will be the powder, the writer (Prof. H.) asks, *what* degree of fineness would be obtained where water is entirely at rest?"—a profound problem, which may be paralleled, and perhaps elucidated in some slight degree, by the enunciation of another of equal significance, bearing upon the laws of motion in general:—If the slower a coach moves the longer it will take to go a mile, how long will it take if it does not go at all?

XIII. Prof. Horsford passing from reef-rocks to coral polyps, suggested with reference to the secretion of carbonate of lime that "the carbonate of lime of the coral, was the fruit of simple double decomposition of the sulphate of lime in sea water, by the carbonate of ammonia exhaled from the living coral." To this suggestion I objected in my former paper, on the ground that the excretions could not turn about and aid in the secretions.* He now says, "it appears to me that the precipitate of carbonate of lime under the circumstances supposed, would take place in the walls of the cellules, where the carbonate of ammonia is set free, and would of course take the form of the cellules:"—thus making the secreting cellules produce, contrary to all that is known, carbonate of ammonia, one of the results of the ultimate decomposition of animal matter.

XIV. The deposition of carbonate of lime from calcareous waters is the last point which I will now mention. Prof. Horsford commences his observations on this subject as follows:

"He (Prof. Dana) remarks: 'Among the modes of consolidation of limestone or carbonate of lime, the following are enumerated by Prof. Horsford; 1, the common mortar process; 2, that of hydraulic cements; 3, that of deposition from calcareous springs.' Of the last he says: 'The waters containing carbonate of lime held in solution by an excess of carbonate of lime, upon reaching the surface under less pressure, and the influence of a high temperature (*higher* temperature, in the manuscript, E. N. H.) give up the carbonic acid so that a precipitation of the carbonate of lime takes place. But is this pressure or a

* I have stated in my report, that the coral polyps have probably the power of deriving the lime by secretion from the sulphate of lime present in the waters; but I have not undertaken to point out the exact character of the change, as the question has not been investigated.

higher temperature needed? The common deposition of carbonate of lime from the waters dripping through the roofs of caverns is evidence to the contrary.'

"I quote the whole literally, with its various inaccuracies to illustrate the haste with which the article was penned.

"The pith of the criticism is the gratuitous intimation that diminished pressure and elevated temperature are not required for the escape of carbonic acid, in order to the precipitation of carbonate of lime held in solution by carbonic acid."

He goes on to illustrate by reference to *soda water*, etc. In another place, after mentioning the remark of the writer, he says, with point, "The reply to this may be found in elementary works on chemistry."

I do not care to damage by my remarks any elementary work on chemistry. But how does the case stand? Prof. Horsford is right as to the pith of my criticism, and also as to my opinions being gratuitous. Now suppose we collect some of the water dripping from the roof of a cavern; and suppose we cool it down at once from 60° F. to 40° F., and allow such a wind as occurs often at the Mammoth Cave to blow over it, would it not evaporate, and the carbonate of lime be thereby deposited? Suppose again the barometric pressure upon that water could be increased from *one* atmosphere to *two*, would not the winds still produce evaporation and a deposition of the lime? There can be only an affirmative reply to these questions. All that is needed is *evaporation*, and this may take place with a *diminished* temperature and *increased* pressure. If we should now take that water and attempt to deposit the carbonate of lime by means of heat, it would be necessary according to such elementary treatises of chemistry as we have seen, to raise the heat to the boiling point of water, before the carbonic acid would be entirely driven off, and the carbonate of lime which it contains, would be deposited.*

In conclusion, I would wish Prof. Horsford better success in his further researches upon coral formations; I doubt not that whatever he may offer which shall throw actual light on the subject, will be gladly welcomed by all. I have entered into this discussion only because erroneous statements unanswered are received by many as truths; and once adopted, they are apt to cling most pertinaciously to the science. The chemistry of coral or calcareous formations is a fair field for research, and important developments will no doubt reward careful study.

* As to the "various inaccuracies" above, on which a grave charge is rested, there is but one which the author has discovered, that of writing carbonate of lime for *carbonic acid:* we could point out almost the same error in the paper we are reviewing; but we think it degrading to descend to such trifles in a scientific discussion. The error of high for *higher*, moreover, is Prof. Horsford's, as he acknowledges; it was printed *high* in the Proceedings of the Albany meeting of the Association, where his article first appeared; and in the *copy* of the paper, *revised by him* for this Journal, where it was published at his request, the error remains uncorrected.

ART. XXXVIII.—*Reëxamination of American Minerals* : PART III—*Danburite ; Carrollite ; Thalite ; Hudsonite ; Jenkinsite ; Lazulite ; Kyanite ; Elæolite ; Spodumene ; Petalite :* by J. LAWRENCE SMITH, M.D., and GEORGE J. BRUSH, Ph. B.

27. *Danburite.*

THIS mineral has as yet been found in this country only at one locality, Danbury, Conn. It was first described by Prof. C. U. Shepard,* and considered by him a hydrated silicate of lime and potash. Still later it was examined by Dr. H. Erni,† and boracic acid was found to be an important ingredient in its constitution ; in his analysis, however, a large amount of alkalies is indicated. As the results of our analyses show but a trace of these substances and no other base but lime, it is possible that Dr. Erni's alkali determination was made, through mistake, on some of the feldspar accompanying Danburite, as it not unfrequently happens that the granular portions of the feldspar resemble the lighter varieties of Danburite. This supposition appears reasonable, as the silica and lime of his determinations agree with those about to be stated.

The composition as given by the authorities mentioned are,

Sï	Cå	Äl					
56·00	28·33	1.70	Ẏ ? 0·85	K̇ (with Ṅa ?) and loss 5·12	Ḧ 8·0	=100.	*Shepard.*
49·74	22·80	Ṁg 1·98	F̈e and Äl 2·11	K̇ 4·31	Ṅa 9·82	B̈ 9·24	=100. *Erni.*

The results of the analyses just made, are as follows :

	1.	2.	3.	4.
Silica, . .	48·10	48·20	——	——
Alumina, }	·30 }	1·02	——	——
Peroxyd of iron, }				
Manganese, . }	·56 }			
Lime, . .	22·41	22·33	22·22	22·11
Magnesia, .	·40	*undeterm.*	——	——
Boracic acid, .	27·73	27·15	——	——
Ignition, . .	·50	·50		
	100·00	99·20		

This corresponds to the following constitution,

		Pr. ct.		Ox. ratio.
4 ats.	Silica, ...	49·42	.	4
3 "	Boracic acid, . . .	28·02	.	3
3 "	Lime, ...	22·56	.	1

It is not easy to decide upon the formula by which Danburite is to be expressed. The same difficulty occurs here as in the case of datholite ; Berzelius considering the lime only as acting the part of base, while Rammelsberg regards the boracic acid also as performing the part of a base. The formula for Danburite under these views would be expressed by

$$2\dot{C}a\,\ddot{S}i^2 + \dot{C}a\,\ddot{B}^3 \quad \text{or} \quad \dot{C}a^3\,\ddot{S}i^2 + \ddot{B}^3\,\ddot{S}i^2$$

* See Am. Jour. Sci., [1] xxxv, 129. † Am. Jour. Sci., [2] ix, 286.

We are in favor of regarding the latter as representing the true formula.

If Danburite be examined in its relation to datholite, it will be found to differ from the latter in having just one half the number of atoms of lime minus three atoms of water.

$$\dot{C}a^6\,\ddot{S}i^2 + \ddot{B}^3\,\ddot{S}i^2 + 3\dot{H} = \text{Datholite.}$$

$$\dot{C}a^3\,\ddot{S}i^2 + \ddot{B}^3\,\ddot{S}i^2 \quad = \text{Danburite.}$$

This mineral forms then the second natural borosilicate of lime. Its physical characters have been fully described elsewhere.

The results of the analysis somewhat surprised us, as we confidently expected to find alkalies; of course much care was directed to the settling of this question, which from the simplicity of the composition of Danburite was easily done in the following manner. To one gramme of the mineral, strong hydrofluoric acid was twice added, the mass carefully heated and evaporated nearly to dryness on each addition; finally, sulphuric acid was added in excess, the whole evaporated to dryness and ignited; the residue weighed 563 milligrammes, of which 544 were sulphate of lime, the remaining 19 being composed of alumina, iron, manganese, and magnesia. The 544 milligrammes of sulphate of lime, correspond to 22·44 pr. ct. of lime in the mineral used, proving, clearly that the remainder was all volatilized under the action of hydrofluoric acid; which according to previous experiments was shown to consist of silicic and boracic acids. Three repetitions of the above experiment gave perfectly concordant results: in fact no more beautiful proof could have been had of the absence of all other bases but lime, in any very sensible quantity. Moreover the amount of lime thus indicated, agrees perfectly with that obtained by the direct method of analysis.

The boracic acid was estimated by first ascertaining the exact amount of silica by a soda fusion, and then deducting this quantity from the entire loss of a given quantity of the mineral under the action of hydrofluoric acid.

The specimens examined were among the finest that have ever been found, and were procured by Mr. Brush at the locality.

28. *Carrollite, a Copper-Linnæite.*

This mineral occurs at Finksburg, Carroll Co., Maryland, and was described as a new species by Mr. W. L. Faber.* He gave as its chemical composition,

S	Co	Ni	Cu	Fe	As	$\ddot{S}i$
27·04	28·50	1·50	32·99	5·31	1·82	2·14

Formula $2CoS + Cu^2S$.

Our attention was first called to this mineral from the unusual relation of the sulphur to the metals in its composition, it being

* This Journal, 2d Series, vol. xiii, 418.

we believe the first example of a natural subsulphuret that had been observed, the relation being R^4S^3.

Having been furnished through the kindness of Prof. Dana, with an abundance of the mineral to select from, which he had procured from original specimens in the hands of Prof. Booth, it was carefully separated from the copper pyrites with which it is associated. *A reëxamination of it gives the following for its* physical and chemical characters. Hardness 5·5; sp. grav. 4·85.* Lustre metallic; color steel gray; fracture uneven, without sufficient indication to make out clearly the nature of its cleavage. The results of three analyses are

	1.	2.	3.
Sulphur,	41·93	40·94	40·99
Cobalt,	37·25	38·21	37·65
Copper,	17·48	17·79	19·18
Nickel,†	1·54	1·54	1·54
Iron,	1·26	1·55	1·40
Arsenic,	trace	trace	trace
	99·46	100·03	100·76

These correspond to the general formula

$$RS + R^2 S^3$$

as will be seen by comparing the amount of sulphur required for the metals indicated in the three analyses with the quantities found.

	1.	Sulphur.	2.	Sulphur.	3.	Sulphur.
Cobalt,	37·25	27·00	38·21	27·68	37·65	27·21
Copper,	17·48	11·65	17·79	11·88	19·18	12·78
Nickel,	1·54	1·12	1·54	1·12	1·54	1·12
Iron,	1·26	·93	1·55	1·15	1·40	1·03
		40·70		41·83		42·14

Substituting cobalt for the copper, iron and nickel, the entire amount of the cobalt would be represented in the three analyses by 56·37, 57·92, and 58·50 pr. ct. The formula requires

	Atoms.	Pr. ct.
Sulphur,	4	42·06
Cobalt,	3	57·94

This is the formula and constitution of Linnæite, and the mineral in question is a copper Linnæite *similar in composition to the one from Riddarhythan, Sweden.*

The composition of this mineral is interesting, as it furnishes the only example in the mineral kingdom of the isomorphism of copper and cobalt, where the latter may be replaced to a greater or less extent by the former. Among artificial products exhibiting this replacement, we have the cupro-sulphate of cobalt with 10 and with 7 atoms of water, the latter crystallizing in oblique prisms, *like the sulphate of cobalt* with the same number of atoms of water, which is also the form of green vitriol.

* *It may be well to remark that there is a typographical error in the statement* of the sp. grav. of Linnæite in Dana's Mineralogy; it is never above 5·00.

† Only one estimate of nickel made.

29. *Thalite, identical with Saponite.*

This mineral was originally described by Dr. D. D. Owen,* by whom it was found on the north shore of Lake Superior, diffused in the amygdaloidal traps of that locality. At the time it was first noticed, it was supposed to contain a new element, which was called thalium; the mineral itself was named thalite. Through the kindness of Dr. Owen we were furnished with some of the mineral, which was subjected to most careful analysis, the result showing nothing in its composition by which it differs from saponite; and all attempts to isolate a new earth from it were vain. A second portion of the thalite, with some of the supposed thalia was sent us by Dr. Genth of Philadelphia, which was labelled, "not quite pure;" its composition, however, differed from the first principally in containing less water, as it was allowed to dry for a greater length of time—it being a common thing for saponites to lose more or less of their water by desiccation in the air.

The result of the examination of the thalite was given in a note in the last number of this Journal. Many of the reactions contained in the original description of thalite and thalia we have been unable to recognize, among them the evolution of chlorine by the action of hydrochloric acid, and the precipitation by a neutral solution of succinate of ammonia. The pea-green color of the concentrated hydrochloric acid solution of the thalia, prepared in the way mentioned by Dr. Owen, is easily explained by the presence of an exceedingly minute quantity of the chlorid of chromium, as the smallest trace of this last metal will, under the circumstances, produce that color.

The results of our analyses are as follows:

	1.	2.
Silica,	45·60	48·89
Alumina,	4·87	7·23
Oxyd of iron,	2·09	2·46
Manganese,	*trace*	*trace*
Lime,	1·07	—
Magnesia,	24·10	24·17
Soda, Potash,	·45	·81
Water,	20·66	15·66
	98·84	99·22

The specimen No. 1, as already stated, came directly from Dr. Owen, No. 2 from Dr. Genth. The original analysis of Dr. Owen, with the exception of the new earth, does not differ very materially from the above, when we consider that the saponites vary more or less in their composition. It is as follows:

$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	new earth	$\dot{M}g$	$\dot{K}$	Mn	$\dot{H}$
42	4·6	1·5	10–12	20·5	0·8	trace	18

* Jour. Acad. Nat. Sci. Philad., ii, part 2d, 1852.

If then the existence of a new earth in this mineral cannot be established, it is clear that it must be a saponite, with which mineral it is identical in physical properties.

30. *Hudsonite, a Pyroxene.*

This species was described by Prof. L. C. Beck.* It has since been shown to be a pyroxene in which a portion of the silica is replaced by alumina. Beck and Brewer obtained for its composition,

$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{C}a$	
36·94	11·22	36·03	2·24	——	12·71 = 99·14.	*Brewer.*†
37·90	12·70	36·80	——	1·92	11·40 = 100·72.	*Beck.*

A recent examination of some specimens has shown the presence of a considerable amount of alkalies. The mineral was received from Mr. Silas R. Horton, and is the same as was sent by him to Prof. Beck. The results of two analyses are,

	1.	2.
Silica,	39·30	38·58
Alumina,	9·78	11·05
Protoxyd of iron,	30·40	30·57
" Manganese,	0·67	0·52
Lime,	10·39	10·32
Magnesia,	2·98	3·02
Potash,	2·48	4·16
Soda,	1·66	
Ignition,	1·95	1·95
	99·61	100·17

Considering the alumina as replacing silica, these give the oxygen ratio of pyroxene and the formula $\dot{R}^3(\ddot{S}i, \ddot{A}l)^2$.

31. *Jenkinsite.*

The green mineral that occurs in velvety coatings on the magnetite of O'Neil's mine, in Orange County, N. Y., has been described by Prof. Shepard.‡ as a new species. Its intimate association with magnetite, renders it somewhat difficult to obtain it perfectly pure; but by placing the fine particles of Jenkinsite in a vessel of water, and stirring the mass with a clean rod of soft iron, that passes through an electro-magnetic coil in connection with a battery, every particle of magnetic iron is removed. Two different portions thus purified, procured at different times from Mr. Silas R. Horton and Mr. John Jenkins, gave

	1.	2.
Silica,	38·97	37·42
Protoxyd of iron,	19·30	20·60
" manganese,	4·36	4·05
Magnesia,	22·87	22·75
Alumina,	0·53	0·98
Water,	13·36	13·48
	99·39	99·28

* Mineralogy of N. York, p. 310. † From Dana's Mineralogy, 3d ed., p. 267.
‡ This Journal, [2] xiii, 392.

From these we obtain the mean oxygen ratio for silica and protoxyds, and water, $19{\cdot}84 : 14{\cdot}50 : 11{\cdot}92 = 4 : 3 : 2\frac{1}{3}$, and the formula $\dot{R}^9 \bar{S}i^4 + 7\dot{H}$.

	Atoms.		At. wt.		Pr. ct.
Silica,	4		2309	=	38·83
Magnesia,	6		1500		25·23
Protoxyd of iron,	3		1350		22·70
Water,	7		788		13·24
			5947		

The mineral is similar in composition to serpentine with one atom more of water, and the magnesia replaced in part by protoxyd of iron and manganese. It also has a strong resemblance to *hydrophite*, both in chemical and physical properties.

32. *Lazulite.*

This species occurs in considerable abundance in Sinclair Co., N. C., which is its only American locality. It is of interest to compare its composition with the European varieties, and for that reason the examination was made.

The sp. gravity was 3·122. Two analyses gave

	Oxygen.			Ox.	
Phosphoric acid,	43·38	= 24·31		44·15	= 24·74
Alumina,	31·22	14·59		32·17	15·03
Protoxyd of iron,	8·29	1·84	5·86	8·05	1·79 5·80
Magnesia,	10·06	4·02		10·02	4·01
Water,	5·68	5·05		5·50	4·89
$\bar{S}i$,	1·07			1·07	
	99·70			100·96	

No. 1, has the oxygen ratio $= 24{\cdot}90 : 14{\cdot}94 : 6 : 5{\cdot}16$, or very nearly $25 : 15 : 6 : 5$.

No. 2, has $= 25{\cdot}56 : 15{\cdot}54 : 6 : 5{\cdot}04$.

From these we deduce the formula

$$2(\dot{M}g, \dot{F}e)^3 \ddot{P} + \ddot{A}l^5 \ddot{P}^3 + 5\dot{H}$$

	Atoms.	At. wt.	Pr. ct.
Phosphoric acid,	5	4460	44·02
Alumina,	5	3209	31·67
Protoxyd of iron,	2	900	8·88
Magnesia,	4	1000	9·87
Water,	5	563	5·56

The formula differs from that of Rammelsberg, by one atom less of alumina and of water; calculated by his formula it would give the alumina much too high for our analyses. The phosphoric acid was separated from the alumina, by fusing the mineral with carbonate of soda and silica, this being the most perfect method, in fact the only one to be safely relied on. It appears to be identical in specific gravity and composition with the variety from Gratz examined by Rammelsberg.

33. *Kyanite.*

Associated with the lazulite just described, is a very beautiful white kyanite. Its composition is

Silica,	37·60
Alumina,	60·40
Peroxyd iron,	1·60
	99·60

This corresponds to the formula $\ddot{A}l^3\ddot{S}i^3$ = silica 37·47, alumina 62·53.

34. *Elæolite.*

The Elæolite of Magnet-Cove in Arkansas, passed under the name of "flesh red feldspar" until recognized by Prof. Shepard.* It has the following physical and chemical properties. Hardness 6. Sp. gr. 2·65. Color flesh-red. Lustre greasy. Structure massive. Chemical composition,

Silica,	44·46
Alumina,	30·97
Peroxyd of iron,	2·09
Lime,	0·66
Soda,	15·61
Potash,	5·91
Ignition,	0·95
	100·65

From this we have the oxygen ratio for the silica, peroxyds, and protoxyds, 9 : 6 : 2, and the formula $R^2\ddot{S}i + 2\ddot{A}l\ddot{S}i$. The mineral examined, was furnished by Mr. Markoe of Washington; it is the one alluded to in our last paper, as containing the compact Thomsonite, under the name of ozarkite. Since publishing the analysis of the latter, we have procured a specimen of the elæolite containing the Thomsonite in handsome radiated crystallisations.

35. *Spodumene.*

Several analyses of this species from Norwich and Sterling, Mass., were given by Mr. Brush in vol. x, of this Journal.

In these analyses, the alkalies were determined as sulphates, and from the amount of sulphuric acid, the relative amount of alkalies was calculated. Since these examinations, it has been found that this process is liable to great inaccuracy: and we have consequently made a reëxamination with direct reference to this point; it has been made altogether on the variety from Norwich, which occurs in beautiful crystals. The results of the reëxamination show that the lithia and soda determinations in the analyses referred to, are erroneous. The method used in this in-

* This Journal, [2] ii, 252.

stance is that recommended by Rammelsberg, the separation of the chlorid of lithia from the chlorids of potash and soda, by a mixture of alcohol and ether.

These analyses gave

	1.	2.	3.
Silica,	64·04	63·65	63·90
Alumina,	27·84	28·97	28·70
Peroxyd of iron,	0·64		
Lime,	0·34	0·31	0·26
Magnesia,	*tr.*	*tr.*	*tr.*
Lithia,	5·20	5·05	4·99
Soda,	0·66	0·82	0·80
Potassa,	0·16		
Ignition,	0·50	0·50	0·60
	99·38	99·30	99·25

From these is deduced the oxygen ratio for the protoxyds, peroxyds, and silica, 1 : 4 : 10 and the formula $\dot{R}^3 \ddot{S}i^2 + 4\ddot{A}l \ddot{S}i^2$, corresponding with the results recently obained by Rammelsberg,* for the composition of the spodumene from Uton and the Tyrol. The silica, however, is somewhat lower than that of the European specimens, which is probably owing to the greater purity of the American mineral, it being found in crystals.

Since completing the above examination of the spodumene from Norwich, we have noticed a recent examination of the variety from Sterling, Mass., by Rammelsberg in which he states his having found 4·5 pr. ct. of potash, and a ratio nearer 1 : 5 : 12, than 1 : 4 : 10. This difference is accounted for by that author on the ground that the mineral is somewhat decomposed, and that the original ratio was 1 : 4 : 10. The fact is, Rammelsberg did not examine the pure spodumene from Sterling, as will be seen by his own account of the specimens analyzed. They were white, yellowish or blueish grey in color, possessing little lustre, penetrated with small fissures, and in these fissures as well as in many places on the surface, were scales of mica with yellow flakes of oxyd of iron ; the specific gravity was 3·073. Now the spodumene, as we have procured it perfectly pure from Sterling, Mass., is of a greenish grey color, fine lustre, and very compact, cleaving with perfection, a specific gravity of 3·182, and with a composition according perfectly with the requirements of the ratio 1 : 4 : 10, containing even a little more lithia than the variety from Norwich. In an early examination by Brush, published several years ago, the silica was given too low, he not having separated the small amount of silica always associated with the alumina. A recent analysis gives as the composition of this spodumene :—

* Pogg. Ann., lxxxv, 544.

			Ox. ratio.
Silica,	64·50		33·41 or 10·66
Alumina,	25·30		
Peroxyd of iron,	2·55		12·54 or 4
Lime,	0·43		
Magnesia,	0·06		
Lithia,	5·65		3·43 or 1·09
Potash and soda,	1·10		
Loss by ignition,	0·30		
	99·89		

It will be seen that this forms no exception, and when examined pure, has the same composition as spodumene from other localities. In fact, so far as the American spodumene is concerned, we believe that the specimens from Norwich are the most beautiful that have been found anywhere, and we shall take pleasure on some early occasion in furnishing Rammelsberg with good specimens from both Norwich and Sterling.

36. *Petalite.*

In connection with the analyses of spodumene, it was thought interesting to examine the American petalite. For this purpose a specimen from Bolton, Mass. was selected. The results of analyses are,—

	1.	Oxygen.		2.	Oxygen.	
Silica,	77·35	40·50		77·90	40·47	
Alumina,	16·63	7·77	7·95	15·85	7·41	7·56
Peroxyd of iron,	0·62	0·18		0·51	0·15	
Lime,	*tr.*			*tr.*		
Magnesia,	0·21	0·08		0·26	0·10	
Lithia,	3·74	2·07	2·27	3·52	1·94	2·18
Soda,	0·48	0·12		0·53	0·14	
Potasa,	*tr.*			*tr.*		
Ignition,	0·60			0·70		
	100·23			99·37		

No. 1, gives oxygen ratio 20 : 3·92 : 1·12.
" 2, " " 20 : 3·74 : 1·08.

or quite nearly 20 : 4 : 1, from which we have the formula $\dot{R}^3\ddot{S}i^4 + 4\dot{A}l\ddot{S}i$ = Silica 78·37, alumina 17·44, lithia 3·40, soda 0·79.

Art. XXXIX.—1. *Action of Nitric Acid on the Chlorids of Potassium and Sodium.*—2. *Action of Oxalic Acid on the Nitrates and Chlorids of the same, with a ready method of converting them into the Carbonates.*—3. *The presence of Oxalic Acid enabling Zinc to decompose Water;* by Prof. J. Lawrence Smith, M.D., of Louisville, Ky.

This note is intended as an appendix to my researches for determining the alkalies in insoluble silicates in this Journal.*

During that investigation, many novel and interesting reactions were observed, several of which have already been alluded to. I present here one or two others of some interest.

* This volume, page 53.

It is well known that if nitric acid be added to a chlorid, or hydrochloric acid to a nitrate, more or less of a decomposition will in either case ensue; but I believe it is not generally known how ready and complete the replacement is, when nitric acid is heated with chlorid of potassium or of sodium.

Among the experiments made, 40 grammes of nitric acid were boiled gently with 6 grammes of chlorid of potassium, and in twenty minutes, no trace of chlorine could be found in the liquid; the same is true when the chlorid of sodium is used. The operations appear to depend on the oxydizing property of the nitric acid, with the liberation of chlorine that combines with some of the elements of nitric acid to form the chloronitric acid that readily passes off. The decomposition of the nitrates of the alkalies by hydrochloric acid does not readily takes place, it not being complete even after repeated evaporations to dryness, with a large excess of hydrochloric acid.

2. Before setling on the plan I now adopt, an easy method was sought for separating the alkalies from magnesia, by converting the two into carbonates,—a plan that had previously been adopted; but the question with me was to change the nitrates to carbonates. The idea suggested itself of heating the nitrates with an excess of oxalic acid. to the temperature at which the latter undergoes decomposition, when the nascent oxyd of carbon might break up the constitution of the nitric acid, and the carbonic acid formed combine with the bases.

On making the experiment, I was surprised to see an abundant evolution of nitrous acid vapors at a temperature considerably below 212°. It was clear that the oxalic acid decomposed the nitrate, liberating the nitric acid, which reacting on the excess of oxalic acid, gave rise to the nitrous acid vapors. If crystallized oxalic acid and the nitrate of potash or soda, the former in excess, be placed together in a flask, and heated over a water-bath, the mass soon enters into watery fusion, and at the temperature of from 130° to 140°, bubbles of gas are evolved, consisting of nitrous acid and carbonic acid; at 212° the evolution is vigorous, and if after evaporation to dryness the water be renewed several times, the nitric acid will be completely expelled from the nitre, there remaining the excess of oxalic acid, and the oxalate of the alkalies.

It was natural to conclude from the above result, that oxalic acid would likewise decompose the chlorids of the alkalies. and on experiment, the conclusion proved to be correct. If an excess of oxalic acid be mixed with either the chlorid of potassium or of sodium, and the whole warmed gently, abundant vapors of hydrochloric acid are evolved, and by careful manipulation, all the chlorine may be driven off under this form.

If heat be applied to the mass resulting from the action of oxalic acid on either the nitrates or the chlorids, all the oxalic acid will be expelled, and the oxalates converted into carbonates. A small amount of chlorid of sodium can in this way be converted in a few moments into carbonate of soda, not, however, without some trace of the chlorid being present. It is not my object to point to any special application of this decomposition, but it is one that may come into play in certain operations in analytical chemistry.

Experiments were made with the sulphate of the alkalies, to see if the oxalic acid had any decomposing action on them, expecting to test for free sulphuric acid, by the action of the solution of the mass on zinc or iron, taking for granted that the presence of oxalic acid alone would not cause the evolution of hydrogen gas. Experiment, however, showed that this manner of testing the question was fallacious. and no other method suggesting itself, it was impossible to decide the question positively ; sufficient was ascertained to show that if the sulphate was decomposed, it was only to a very minute extent.

In connection with this last experiment, it is proved that zinc decomposes water readily in presence of oxalic acid, hydrogen gas being evolved ; the action ceases in a short time, from the formation of insoluble oxalate of zinc ; with iron, the action is very feeble even when the solution is heated.

The decomposing action of oxalic acid on the nitrates and chlorids of alkalies, appears to be due simply to the fact of a more stable acid being able to replace a more volatile one. and in no way measures the relative strengths of the acids ; it being a well established fact that the physical as well as chemical properties of acids have much to do with their capability of replacing each other ; a mere change of circumstances often reversing their relative action.

Art. XI.—*On the Blood-corpuscle-holding Cells, and their relation to the Spleen ;* by W. I. Burnett, M.D., Boston.

The history of the spleen is a remarkable one in physiological science. From the earliest times to the present day, it has been the opprobium of investigators. and the dignified old Haller, after searching in vain for its functional relations, concluded that it was an unimportant and unworthy part in the economy. No less than fifteen theories as to its use have been advanced and defended up to the present time ; these embrace every ostensible view of its function, having any ground of plausibility. It can be easily conceived, then, that modern physiologists might conclude. when at last from chemical and microscopical research, the true function of this

organ should be made out, that it would be only one of the old theories revived. But this, modern ingenuity has shown may not be the case; for, quite recently a theory has been advanced on this subject, which is unique and in no respect like any of the preceding. Kölliker, the distinguished Wurtzburg professor of anatomy and physiology, maintains that the spleen is the blood-destroying organ. It is indeed a significant question in physiology —what becomes of all the blood-corpuscles that have been used in the system? We find no traces of their decay in the blood-vessels, and, from all the appearances in the circulation, they never pass away. After they have served their part as oxygen-carriers, where is their final resting place? Kölliker supposes that this refuge is in the spleen, an organ in which they congregate, assume the form of globular masses, then crumble and are dissolved, passing off for a biliary or some other purpose.

This point opens for discussion several interesting topics, chief among which is the *modus operandi* by which Kölliker thinks this process is accomplished.

In order to understand this, the general relations and the intimate structure of the spleen must be briefly noticed.

None of the Invertebrata possess this organ: but it may be said, in general, to be present in all the Vertebrata, for its doubtful existence is with some of the Myxinoid fishes only, and even here it may well be questioned if the general rule does not hold good. It is evident, therefore, that the Vertebrata have relations in their economy on which the presence of this organ depends. This point, however, will be reserved for future discussion. In its gross aspect, the spleen appears as a red, pulpy organ, with white points here and there dotting its surface when its investing membrane is removed, or when its structure is exposed by an incision. This red, pulpy matter is composed chiefly of blood-vessels held in place by an intercellular or delicate parenchymatous substance made up of nucleated cells, and of peculiar muscular fibres which are of recent description.

The white points are the Malpighian corpuscles, which consist of vesicles filled with granular, nucleated cells not unlike those found in the general parenchyma. Such is the intimate structure of this organ with the higher Vertebrata; but with the lower Vertebrata, it is much less complex, no Malpighian bodies being found. On the whole, the spleen is a vascular, parenchymatous organ, composed so largely of blood-vessels that it has much variability of size in the same individual according to the flaccidity or turgidity of these vessels. We will now proceed to the points at issue in Kölliker's theory of the function of this organ.

In the splenic tissue of many animals, there are not unfrequently observed roundish or oval masses of a brownish color, and of a size varying from $\frac{1}{200}$ to $\frac{1}{1500}$ of an inch in diameter. These

appear to be aggregations or collections of blood-corpuscles which may or may not be invested with a distinct capsule. These corpuscles are in some stage of disintegration, and appear more or less brown, as this dissolution proceeds. These bodies, Kölliker thinks occur very generally and constantly in the spleen, and he supposes that, by them, this organ serves for the working up of old worn out blood-corpuscles.*

I need scarcely say that so novel a theory, and one, too, with such ostensible plausibility, has attracted the attention and provoked much discussion among physiologists. Indeed, I know of no special subject in physiology, that has received more attention from some of the best Microscopists, than this; Remak, Ecker, Virchow, Gerlach, Reichert, Kölliker, and many others, have given it special attention, and already its literature is not insignificant. I cannot here give an analysis of the somewhat different results of these observers, but it may be mentioned that although all admit that bodies such as I have described, do occur in the spleen, yet none of them, as I understand, accept Kölliker's hypothesis of their functional relations,† and all have not observed them with that frequency and constancy mentioned by Kölliker. As for myself, I have carefully examined the spleen throughout the Vertebrata, with special reference to the doctrine in question. These examinations have extended through whole tribes of fishes, reptiles, birds and mammals. I have not found these bodies by any means as common as Kölliker has stated; indeed they have appeared to me under circumstances which seemed more accidental than normal, and, with comparatively few exceptions, they were unenclosed by a distinct membrane. This was found to be the case especially with birds and reptiles. It is true that with the rabbit and other rodents which I have examined, these bodies were regularly saccular when present, but they were of various sizes; and it is worthy of notice that, in these animals, blood, taken from other parts of the body, showed a disposition to a grouping of its corpuscles into masses of variable size.

In some reptiles I have found these bodies present at one time and absent at another, and with the frog, where Kölliker says they may be beautifully seen, I have generally failed to detect them. On the whole, then, my conclusion is, that the blood-corpuscle-holding cells of Kölliker, are accidental rather than normal productions, and that they sustain no relations to the function of the spleen. I regard them as simple, minute extravasations of the blood into the spleen parenchyma, which may or may not be invested with a membrane according to the greater or less plasticity of the blood.

* This view Kölliker advanced in 1847, but it was first enunciated in a complete form in 1849, in the article *Spleen*, in the Cyclop. Anat. and Physiol. See literature.

† I would except Gerlach, Ecker, and Beclard; see literature, beyond.

This view is supported by many facts which have been observed in both physiology and pathology. If inflamed blood be drawn from the body and allowed to stand, there are, not unfrequently, found at the bottom of the vessel, bodies consisting apparently of little sacs filled with blood-corpuscles. This is due to the fact that a certain number of corpuscles become collected into one mass and this last is then invested by a membrane composed of the blood-plasma.

That this is the correct version is shown by the fact that these capsular bodies sometimes include other matters beside simple blood-corpuscles, and Kölliker himself mentions a case where, in an extravasation of blood into the *commissura mollis*, he found them containing pieces of cerebral substance. I would mention also, that I have observed these conditions distinctly marked in some blood of an elephant. which was recently examined.

My opinion, finally, is like that of Remak, that these peculiar bodies are minute blood-clots, (*Blutgerinnsel*) of accidental occurrence, and of no physiological significance.

It now remains for me to notice in this connection another subject, to which the one we have just treated is somewhat allied. I mean the so-called pigment-holding cells of Remak. The history and relations of these bodies have been brought out recently by the discussion of the constituents of the spleen to which we have just alluded. If the spleen of fishes is examined, there will be found on the sheath of some of its smaller arteries, roundish or oval bodies, which consist of a thick-walled capsule enclosing pigment granules. These are the bodies in question; they have not unfrequently been mistaken for the Malpighian corpuscles. They are tough, and the last parts of the spleen to decay, so that they are often best seen when the contiguous parts are just beginning to disintegrate.* I have never observed them in this connection with the minute arterial sheaths except in fishes. Here I have carefully studied them; they appear to be perfectly closed sacs, and have no communication with the artery on which they rest.

The constancy of their presence, as well as the general regularity of their size in individual species, would lead me to agree with Remak in considering them as true physiological organs. They seem to be producers of pigment granules, the ulterior use of which remains yet to be discovered. It may be that these granules are concerned in the coloring and special constituents of the bile.

The following appears to be the most probable view of the function of the spleen in the economy, as elucidated by the more modern microscopical studies.

* For figures of these bodies, see,—
Kölliker, Article *Spleen*, Cyclop. Anat. and Phys., 1849.—*Ecker*. *R. Wagner's* Icones physiol., Lfrg. I, 1851, Taf. vi.—*Remak*, *Müller's*, Arch. 1852, p. 115 Taf. v, fig. 4, 9, 10.

I think there can now be but little doubt that the systematic position of the spleen is in the category of ductless glands,—belonging, as to its physiological signification, with the Supra-renal capsules and the Thymus and Thyroid bodies. Its structure and its development, both, indicate the correctness of this view.

Experiments have shown that, whatever may be its function, the presence of the spleen is far from being indispensable in the body or even necessary for its health.* The whole history of its formation and development in the embryo, clearly shows that it can have no particular function during the embryonic life. In the chick, where its earliest conditions have been most carefully traced, it is found that it reaches no functional capacity,† until the period of incubation is over.

Its relations to the economy then do not begin until the animal has commenced to have a nutrition of its own. In this respect, therefore, it is inverse to the other ductless glands; for as has been well shown by Ecker and other observers, the Thymus and Thyroid bodies, and the Supra-renal capsules, are truly embryonic organs, and cease to perform any function in the individual animal.

I would, therefore, say that the whole tenor of present research upon this organ, combined with many incidental pathological phenomena, favor the view that the spleen has functional relations in the adult life, corresponding to those of the other ductless glands, just mentioned, in the embryo; that is, it is intimately connected with the formation of the red-corpuscles of the blood. I would not say with Gerlach and Schäffner‡ that it is the locality where these corpuscles are formed,—but rather that it has more the office of a lymphatic gland where the plastic materials of the blood are prepared and made ready for their conversion into the red-corpuscles; or, to speak more to the point, it is one of the organs in which chyle-corpuscles are formed and eliminated preparatory to their being changed into, or rather serving as the basis for the formation of, the true red-corpuscles. The Malpighian vesicles are undoubtedly prominent agents in these processes, and Gray has shown that their development here is precisely like that of the vesicles in the Thymus and Thyroid glands. In this connection should also be mentioned the fact of the existence of the spleen in all the vertebrates which have both red and white corpuscles in their blood, and its non-existence with all the Invertebrata which have the white corpuscles alone. Moreover, the spleen is most prominent in those vertebrates which have the red constituents of the blood most marked, while with the Myxi-

* The sensible remark of Haller is well worthy of quotation in this connection "In ultimo aliquam partem corporis animalis esse, tam latè per diversas species regnantem, in ligram est dictu."—Elem. physiolog. vi, 426.

† See *Gray*, "On the development of the ductless glands in the chick." Philos. Trans. 1852, part ii, p. 295.

‡ See literature, beyond.

noid fishes, whose blood quite resembles that of the Articulata, the spleen is so feebly developed that its existence was for a long time denied.

These data are worthy of remembrance, and without a more detailed discussion, I think we are justified in concluding, if any conclusion is now proper, that *the spleen is a vascular-lymphatic gland, whose function is intimately connected with the formation of the blood, by the elaboration of chyle-products.*

Literature of the Blood-corpuscle-holding Cells.

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Art. XLI.—*Extraordinary Fishes from California, constituting a new Family, described* by L. Agassiz.

About fifteen months ago, I received a letter from A. C. Jackson, Esq., soon after his return from San Francisco, California, informing me that while fishing in San Salita Bay, he had caught with the hook and line, a fish of the perch family, *containing living young*. The statement seemed so extraordinary, that though an outline of the specimen observed was enclosed, I suspected some mistake, and requested Mr. Jackson to furnish me further information upon what he had actually seen, and if possible specimens of the fish preserved in alcohol. To this enquiry, I received the following answer:

"I regret much that the information which I sent you avails so little, without the actual specimens of the fish and young; these however, I have already taken active measures to obtain, and trust before many months to be able to send you at least specimens of the female, if not of the young. I should at the time I caught the fish have preserved them in alcohol, but at that time I was attached to the Navy Yard commission, and was with my comrades industriously prosecuting the examination of the vicinity of San Salita, as to its adaptiveness for a navy yard, and could not leave for San Francisco without suspending the work, and the means for preserving the fish could not be otherwise procured. This explains the apparent culpable indifference which allowed me to omit preserving the specimens. I have sent directions to California to have caught for me several of the fish, and if at the present time (September 16th, 1852) the females were pregnant (which is not probable) to take from one the bag containing the young, and put mother and young in the jar of alcohol, and to put several other females untouched, into the jar also. These specimens will by direction and examination even if they be not pregnant, and if the jar contains no young, determine the truth and accuracy of the statement I made in my former letter on the subject. This fact proved by these specimens, it will be very easy to obtain during the next spring and summer, specimens in all stages of pregnancy. I think, if I remain in the country, I can insure you a sufficiency of specimens, to determine to your satisfaction, the true state of the affair, during the course of the next year. The fish I refer to, in my opinion, does not exist in very great numbers even in the waters of San Salita Bay, for the two which I caught on this occasion were the only ones which I fell in with, though I fished in the same place probably four times. There was a little peculiarity perhaps in the circumstance of my taking them as I did. I had previous to this time, tried my rod and line, as I mentioned before, four times, always with success as regards groupers, perch, &c., without a sight of the singular fish under consideration. A few days, perhaps a week, after the four trials, and on the *7th of June*, I rose early in the morning for the purpose of taking a mess of fish for breakfast, pulled to the usual place, baited with crabs, and commenced fishing, the wind blowing too strong for profitable angling; nevertheless on the first and second casts, I fastened the two fishes, male and female, that I write about, and such were their liveliness and strength, that they endangered my slight trout rod. I however succeeded in bagging both, though in half an hours subsequent work I got not even a nibble from either this or any other species of fish. I determined to change the bait, to put upon my hook a portion of the fish already caught, and cut for that purpose into the largest of the two fish caught. I intended to take a piece

from the thin part of the belly, when what was my surprise to see coming from the opening thus made, *a small live fish.* This I at first supposed to be prey which this fish had swallowed, but on further opening the fish, I was vastly astonished to find next to the back of the fish and slightly attached to it, *a long very light violet bag, so clear and so transparent, that I could already distinguish through it the shape, color and formation of a multitude of small fish (all fac-similes of each other) with which it was well filled.* I took it on board (we were occupying a small vessel which we had purchased for surveying purposes.) when I opened the bag, I took therefrom *eighteen* more of the young fish, precisely like in size, shape, and color, the first I had accidentally extracted. *The mother was very large round her centre, and of a very dark brown color, approaching about the back and on the fins a black color, and a remarkably vigorous fish.* The young which I took from her were in shape, save as to rotundity, perfect miniatures of the mother, formed like her, and of the same general proportions, except that the old one was (probably owing to her pregnancy) much broader and wider between the top of the dorsal and the ventral fins, in proportion to her length than the young were. *As to color they were in all respects like the mother, though the shades were many degrees lighter.* Indeed, they were in all respects like their mother and like each other, the same peculiar mouth, the same position and shape of the fins, and the same eyes and gills, and there can not remain in the mind of any one who sees the fish in the same state that I did, a single doubt that these young were the offspring of the fish from whose body I took them, and *that this species of fish gives birth to her young alive and perfectly formed, and adapted to seeking its own livelihood in the water. The number of young in the bag was nineteen,* (I fear I mistated the number in my former letter.) *and every one as brisk and lively and as much at home in a bucket of salt water, as if they had been for months accustomed to the water.* The male fish that was caught was not quite as large as the female, either in length or circumference, and altogether a more slim fish. I think we may reasonably expect to receive the specimens by the first of December. But I can hardly hope to get satisfactory specimens of the fish as I found it with young well grown, before the return of the same season, viz., June. By that time I trust the facts will be fully decided, and the results, as important as they may be, fully appreciated."

In a subsequent letter, (dated January 31, 1853,) Mr. Jackson informed me that he had requested Capt. Case, U. S. N., who commanded a sloop of war in San Francisco, and who had also seen the fish, to supply my friend T. G. Cary, Junr., Esq., of San Francisco, with specimens of that fish, should he succeed in getting any. I wrote myself also to Mr. Cary, to be on the look out for this fish.

About a fortnight ago, I was informed by Mr. Cary, in a letter dated San Francisco, August 10, 1853, that after a search of several months he had at last succeeded in obtaining several specimens of this remarkable fish, three of which were sent by express, (which have reached me lately), while a larger supply was shipped round Cape Horn. After a careful examination of the specimens, I have satisfied myself of the complete accuracy of every statement contained in Mr. Jackson's letter of February, 1852, and I have since had the pleasure of ascertaining that there are two very distinct species of this remarkable type of fishes, among the specimens forwarded to me by Mr. Cary. I propose for them the generic name of Embiotoca, in allusion to its very peculiar mode of reproduction.

I feel some hesitation in assigning a family name to this type. It is probable that all its members will present the same peculiarity in their mode of reproduction, and that therefore the name *Embiotoca* may with perfect propriety be modified into *Embiotocoidæ*, as Didelphis has given its name to a numerous family, the *Didelphyidæ*, after having been for a long time simply a generic name. Should it however be found that other types of this family present various modifications in their vivaporous reproduction, for which the name *Embiotocoidæ* might be objectionable, I would propose to frame some family name from another structural peculiarity of these fishes, not yet observed in any others, the naked furrow-like space parallel to the base of the posterior dorsal fin, separating the scales which cover the base of the rays, from those of the sides of the body and name it *Holconoti*.

The perseverance and attention with which Messrs. Jackson and Cary have for a considerable length of time been watching every opportunity to obtain the necessary materials for a scientific examination of these wonderful fishes, has induced me to commemorate the service they have thus rendered to zoology by inscribing with their names the two species now in my hands, and which may be seen in my museum in Cambridge, labelled *Emb. Jacksoni* and *Emb. Caryi*..

A country which furnishes such novelties in our days, bids fair to enrich science with many other unexpected facts, and what is emphatically true of California, is in some measure equally true of all our waters. This ought to stimulate to renewed exertions not only our naturalists, but all the lovers of nature and of science in this country.

Family *Holconoti* or *Embiotocoidæ*.

The general appearance of the fishes upon which this family is founded, is that of our larger species of Pomotis, or rather that of the broader types of Sparoids. Their body is compressed, oval, covered with scales of medium size. The scales are cycloid, in

which respect they differ widely from those fishes they resemble most in external appearance. The opercular pieces are without spines or serratures. Branchiostegal rays six. The mouth is encircled by rather thick lips; the intermaxillaries forming by themselves the whole margin of the upper jaw. The intermaxillaries and upper maxillaries are slightly protractile. Teeth only upon the intermaxillaries, lower maxillaries and pharyngeals; none either upon the palatines or the vomer. In this respect, as well as in the absence of spines and serratures upon the opercular pieces, they differ much more from the Percoids, than from the Sparoids; but the cycloid scales remove them at once from the latter, in which the scales present a very uniform ctenoid type. The thick lips might remind one of the Labroids, but the scales of the Embiotoca are neither elongated, nor provided with the characteristic branching tubes of that family.

One long dorsal fin, the anterior portion of which is supported by spinous rays, and the posterior by numerous articulated branching rays, which are sheathed at the base by two or three rows of scales, *separated from those of the body by a rather broad and deep scaleless furrow*. This last peculiarity has not yet been observed in any fish, as far as I know. There is indeed a distinct longitudinal space parallel to the soft portion of the dorsal, nearly of the width of a single row of scales, which is entirely naked and well defined, forming as it were, a furrow between the scales of the back, and those which rest against the base of the fin rays. Though protected in this way by a kind of sheath, the anterior part of the dorsal fin alone can be folded backwards and entirely concealed between these scales, as in many Sparoids; the posterior part only partially so. Moreover, the scales of the sheath are separated by a furrow from those of the back, only along the base of the soft part of the dorsal fin. The first rays of the anal fin are short, comparatively small and spinous. The base of this fin is strangely arched, and sheathed between scales, in the same manner as the dorsal; the spinous rays when folded back being more fully concealed in the sheath than the soft rays.

The ventrals are subthoracic as in the Sparoids, and provided with a strong spinous and five soft rays.

Four branchial arches, supporting four complete branchiæ with two rows of lamellæ in each. The opening behind the last arch is very small and entirely above the base of the pectoral fins. Pseudobranchia very large, and composed of sixteen or seventeen lamellæ. The alimentary canal is remarkably uniform in width for its whole length. It extends first on the left side as far back as the ventrals, turns forwards and upwards to the right, then follows the middle line along the *large air bladder*, to the second third of the abdominal cavity, then bends along the right side downward and slightly forwards almost to meet the first bend, when it

turns backwards again, and ends in a straight course at the anus. The stomach can not at all be distinguished externally from the small intestine by its size and form. There are no *cæcal appendages at all* in any part of the intestine. The whole alimentary canal contained large numbers of shell fragments of small Mytili. The liver has two lobes, a short one on the left side, and a long one along the middle line of the body.

The female genital apparatus, in the state of pregnancy, consists of a large bag, the appearance of which in the living animal has been described by Mr. Jackson; upon the surface of it large vascular ramifications are seen, and it is subdivided internally into a number of distinct pouches, opening by wide slits into the lower part of the sack. This sack seems to be nothing but the widened lower end of the ovary, and the pouches within it to be formed by the folds of the ovary itself. In each of these pouches a young is wrapped up as in a sheet, and all are packed in the most economical manner as far as saving space is concerned, some having their head turned forwards, and others backwards. *This is therefore a normal ovarian gestation.* The external genital opening is situated behind the anus, upon the summit and in the centre of a conical protuberance formed by a powerful sphincter, kept in its place by two strong transverse muscles attached to the abdominal walls. The number of young contained in this sack seems to vary. Mr. Jackson counted nineteen; I have seen only eight or nine in the specimens sent by Mr. Cary, but since these were open when received, it is possible that some had been taken out. However, their size is most remarkable in proportion to the mother. In a specimen of Emb. Jacksoni, $10\frac{1}{2}$ inches long, and $4\frac{1}{2}$ high, the young were nearly three inches long and one inch high; and in an Emb. Caryi, eight inches long, and $3\frac{1}{4}$ high, the young were $2\frac{3}{4}$ inches long, and $\frac{5}{8}$ths of an inch high. Judging from their size, I suspected for sometime that the young could move in and out of this sack like young opossums, but on carefully examining the position of the young in the pouches, and also the contracted condition of the sphincter at the external orifice of the sexual organs, I remained satisfied that this could not be the case, and that the young Mr. Jackson found so lively after putting them in a bucket of salt water, had then for the first time come into free contact with the element in which they were soon to live; but at the same time, it can hardly be doubted that the water penetrates into the marsupial sack, since these young have fully developed gills. The size of the young compared with that of the mother is very remarkable, being full one-third its length in the one, and nearly so in the other species. Indeed these young Embiotocæ, not yet hatched, are three or four times larger than the young of a Pomotis (of the same size) a full year old. In this respect these fishes

differ from all the other viviparous species known to us. There is another feature about them of considerable interest, that while the two adult differ markedly in coloration, the young have the same dress, light yellowish olive with deeper and brighter transverse bands, something like the young trouts and salmons in their Parr dress. The transversely banded species may therefore be considered as inferior to the other, since it preserves through life the system of coloration of the embryo.

It will be a matter of deep interest to trace the early stages of growth of these fishes, to examine the structure of the ovary and the eggs before fecundation takes place, etc., etc. The state of preservation of the specimens in my hands, precluded every such investigation.

Though I know thus far only one single genus of this type, I do not think it right to combine the generic characters with those of the family, as is generally done in such cases, as I would also object to the practice of omitting any specific characteristics where only one species is known of a genus. This shows an entire misapprehension of the relative value and subordination of the characters of animals. I would therefore characterize as follows the genus

Embiotoca, Agass.

Body much compressed and elevated. Head small, with scales only on the cheeks and opercular pieces. Teeth in both jaws, short, conical, arranged in one row, and slightly recurved. The pharyngeal teeth much shorter and blunter than those of the jaws, and arranged like pavement. Dorsal fin with nine or more spinous rays. The first three rays of the anal fin, spinous, and much shorter than the following articulated rays, which are always finer and more numerous than the corresponding rays of the dorsal fin. The lateral line is continuous to the base of the caudal fin. Whether the peculiar mode of reproduction is a family or a generic character, remains to be ascertained by further investigations. It is however probable that with some slight modifications it will be found the same in all the members of the family.

Some differences between the two species observed, might render it doubtful whether they ought to be considered as belonging to as many distinct genera or not. But we know that in genera differing greatly from others, the range of the specific differences is also wider than in genera with many species; so until I am taught differently by new discoveries, I would refer them both to one and the same genus. Such doubts could scarcely be entertained respecting families with many genera, where a standard to estimate genuine generic differences is easily obtained.

1. *Embiotoca Jacksoni*, Agass.

The body is quite high, of an oval form, greatly compressed and similarly arched above and below. The superior arch extends to the posterior base of the dorsal fin, whence it continues in a horizontal line to the base of the tail. The ventral arch of the body is similar to that of the dorsal outline. The profile from the dorsal fin to the end of the snout, is rather precipitate and regularly arched, except obliquely above and in front of the eyes, where it is slightly concave. The greatest height of the body, including the dorsal fin, is equal to the distance from the end of the snout to the extremity of the pectoral. The greatest thickness of the body is equal to one-fourth its height. The head is of moderate size, its length, measuring to the posterior angle of the opercle, being about one-fourth that of the entire fish. The mouth is quite small, the hind extremities of the intermaxillaries and maxillaries extending not farther back than the line of the anterior border of the orbit. But a small portion of the superior maxillary is exposed at the angle of the mouth. The anterior edge of that part of the snout into which the intermaxillaries fit, is on a horizontal line drawn immediately below the orbits. The upper jaw is slightly more prominent than the lower, the teeth of the latter fitting *within* those of the former. In the upper jaw there are fourteen or fifteen teeth; in the lower there are two or three less. They all are slightly swollen near the top, and are not pointed but rather bluntly edged. They do not extend to the angles of the mouth, but leave a space without teeth on each jaw. The teeth of the upper jaw are but little larger than those of the lower. The teeth of the pharyngeals are much shorter than those of the jaws, and form two quite moveable plates above, and a triangular one below. There are not more than thirty teeth on each of the superior plates, and mostly truncated at the top. The four or five teeth, which form the inner row of each plate, are more prominent than the others, and somewhat pointed. The teeth of the inferior pharyngeal plate are similar to those of the upper, but the teeth of its posterior range are the most prominent, and pointed. The lips are rather fleshy, and entirely conceal the teeth. Beneath the lower lip there is an elongated pit on each side, extending towards the corners of the mouth; it is covered by a thin border of the lip. The distance from the end of the snout to the anterior border of the orbit, is greater than the diameter of the latter by one-third. The inferior margin of the orbit is on the middle longitudinal line of the body; and its posterior border is half way between the end of the snout, and the posterior angle of the opercle. The opercular pieces are large. On the preopercle are four concentric rows of scales; the two inner and anterior are the longer. There are thirteen large scales in the row nearest the eye, and the number is

less and less in the others. Still within the row nearest the eye, there is a space without scales, and marked by pores radiating from the edge of the orbit. The posterior and inferior border of the preopercle, outside of the ridge of the latter, is thin, membranous, and without scales, but marked with numerous pores or tubes similar to those around the orbits, and radiating from within outwards.

The opercle, subopercle, and interopercle are covered with scales, which decrease in size from the former to the latter. There is a narrow membranous border to the opercle, extending from its posterior angle to the height of the termination of the lateral line. The notch between the subopercle and interopercle is on a vertical line with the edge of the posterior border of the preopercle. There is a small patch of scales, nine or ten in number, immediately above the superior attachment of the preopercle. The dorsal fin extends over about $\frac{3}{5}$ths of the superior curve of the body; its posterior portion is one-third higher, as well as longer, than its anterior. The spinous portion has nine or ten rays, the length of the first of which, is equal to one-third that of the last. At the point of each spine, the fin appears to extend backwards in a loose filament. There are $19\frac{3}{4}$ articulated rays in the dorsal fin: the superior outline of this part is nearly similar to that of the back, although the rays of its first half are the longest, and nearly equal in length. The furrow on each side extends as far forwards as the base of the first articulated ray, where there are three rows of scales forming the sheath; but the rows are reduced to one towards the posterior attachment of the fin.

The pectoral fins are of rather large size, and are placed below the middle line of the body, as well as below the posterior angle of the opercle. They extend about as near to the anal fin, as do the ventrals. The second ray of the pectoral is but slightly arched towards its extremity. There are twenty-one rays in each pectoral. The base of the ventrals is just in advance of the middle of this second ray of the pectoral. The spinous ray of the ventrals is $\frac{9}{5}$ths the length of the following articulated ray. There is a long plate of scales between the ventrals. The anal fin is broad and composed principally of fine slender rays. The last and longest of its spinous rays, equals in length $\frac{1}{4}$th that of the following articulated ray, which latter is equal to the corresponding ray of the dorsal fin. The last ray of the anal fin is placed nearer the caudal fin than that of the dorsal. The fin itself reaches nearer the base of the tail. The caudal fin is deeply forked; it contains fourteen rays, omitting its outer and short rays. There are eight rows of scales between the lateral line and the spinous portion of the dorsal fin, and eighteen rows below the lateral line in the same region. Sixty scales in the lateral line. Color uniformly dark olive brown, along the back, fading slightly upon the sides; dor-

sal black, mottled with white; caudal blackish, lighter upon the base; anal deep black, with a light longitudinal band; pectorals white; ventrals black with light base.

From the above description, it must be obvious that this is the species first observed by Mr. A. C. Jackson, to whom I have inscribed it, or at least a species very closely allied to it. There is only one fact about it which surprises me, that while he observed mature young in it on the 7th of June, Mr. T. G. Cary should have found it still with young as late as the beginning of August. Again Mr. Jackson saw nineteen young in it, whilst in the specimens forwarded by Mr. Cary, I found only eight or nine young, which were transversely banded like Emb. Caryi. May there be two species so closely allied as to be easily mistaken? I must add, that Mr. Jackson does not mention the mottled appearance of the dorsal, nor the light band upon the anal of his fish; which renders the supposition more probable that there are several and not only two species of this remarkable genus, about San Francisco. I would however, not forego the opportunity of connecting the name of Mr. Jackson with his interesting discovery, and have therefore called *Emb. Jacksoni*, that one of the species sent me by Mr. Cary, which agrees most closely with his description, leaving it for the future to decide whether this species is truly the one he first saw, a circumstance which is quite immaterial, since we already know two species of this extraordinary type.

2. *Embiotoca Caryi*, Agass.

The body is much more elongated than in Embiotoca Jacksoni yet equally compressed. Its height, including that of the dorsal fin, is less than the distance from the end of the snout to the extremity of the pectoral: and less than one-half the length of the fish. The profile is much less steep, and the snout quite as prominent, hence the head is longer than high. The posterior border of the orbit is nearer the angle of the opercle than the end of the snout. The upper and lower curves of the body are equal, and approach more nearly towards the tail, making this latter narrower than in the first species. The scales of the back do not descend upon the head lower than one-half the distance from the first spine of the dorsal to the end of the snout. The forehead is slightly concave as in Emb. Jacksoni. The posterior end of the intermaxillary does not extend as far back as the anterior border of the orbit. The nature of the lips, and extent of the upper maxillary is much as in the other species, but the anterior edge of the socket of the intermaxillaries is *above* the line of the lower border of the orbit.' A vertical line through the orbit shows the height of the head in this region to be one-third less than in E. Jacksoni. The opening of the mouth is directed more obliquely

upwards. The teeth are more slender, but have otherwise the same form. In the upper jaw there are twelve, in the lower eight teeth. The nasal openings are of tolerable size; one before the other, and in advance of the eye, but slightly below the line of its superior border. The vertical diameter of the orbit is less than its longitudinal; and its posterior border is nearer the angle of the opercle than the snout. The preopercle in this species is less rectangular than in the former. The inferior rounded angle of its *ridge* is in *advance* of the posterior margin of the orbit. The scales of the preopercle are also much smaller and less conspicuous. Tubes radiate from the border of the orbit and from the ridge of the preopercle, as in Emb. Jacksoni. The posterior membranous border of the opercle is narrower: the notch between the subopercle and interopercle is on the vertical line of the posterior border of the preopercle. There is a patch of scales above the superior attachment of the preopercle. The dorsal fin differs very little in form from that of the former, but extends somewhat farther forwards, its first spine being immediately over the posterior angle of the opercle. The distance from this spine to the end of the snout equals the distance from the same back to the ninth articulated ray. The posterior rays of the articulated portion, are shorter than in the first species, but they are more numerous by three rays. The pectoral has twenty-one rays; it is perhaps longer than in the other. The ventrals differ little. The anal fin however, differs greatly: it is very small and contracted, and is placed far behind the ventrals. The scales at its base form a waved outline much more marked than in E. Jacksoni. The spinous rays are very short, the last being less than one half the length of the following articulated ray, the base of which latter is directly under that of the fifteenth corresponding ray of the dorsal fin. Its posterior base and termination are as in the first species. The caudal fin however, is more slender, and more deeply notched. The scales of the body are by no means so large. The lateral line, follows the outline of the back, as in E. Jacksoni; there are seventy-five scales in it.

Color light olive, darker along the back; light brown longitudinal bands extend between the rows of scales, and darker transverse bands reach from the back to the sides of the body, not extending below the lateral line in the anterior part of the trunk, but more marked, and reaching nearly to the anal fin upon the tail. Head mottled black and white. Dorsal and caudal dotted with black and white. Anal with a large diffuse black mark upon lighter ground. Pectorals white. Ventrals white at the base, terminated with black.

Only one female has been observed, containing eight young. This species was discovered by T. G. Cary, Esq., in the Bay of San Francisco, in the beginning of August 1853.

ART. XLII.—*On a change of Ocean Temperature that would attend a change in the level of the African and South American Continents;* by JAMES D. DANA.

THE idea of a change of climate consequent upon a change in the distribution of land and water on the globe, brought forward by Sir Charles Lyell, has recently been discussed with much ability and precision, by Prof. Hopkins, especially with reference to the Northern Atlantic. As there is profit in this consideration of possibilities whether we can prove the actual occurrence of the supposed events or not, we briefly remark in this place upon another geological change that would affect the temperatures of both the Pacific and Atlantic Oceans.

Upon the oceanic isothermal chart issued with the last number of this Journal, and discussed in that and this number, it is observed that the whole western coast of South America is bordered by cold waters; and that while in the Pacific, 80° F. is the coldest temperature of the year in mid-ocean, towards South America, even under the equator, the ocean temperature of 74° is not found, in the cold season, short of a distance of 2500 miles from the coast.

We have also remarked upon the evidence that a similar southern or extratropical current affects the temperature of the whole southern Atlantic, (see page 320) and makes this literally the cold ocean of the globe.

It is moreover evident from the temperature of the waters off western South America, that the extratropical or antarctic current has a vastly wider influence here than in the southern Atlantic; the positions of the lines of 68° and 74° in the two regions make this sufficiently apparent. It is also obvious, that the South American Continent, by extending so far south,—22 degrees, or 1300 miles, beyond the south point of Africa,—should necessarily intercept to a large extent the antarctic current, and thus occasion in connection with other causes, the northern flow that influences so widely the temperature of the waters off this coast. The position of the isocryme of 35°, shows that this same current flows on, rising somewhat northward towards Cape of Good Hope; yet the African continent lies so far to the north, that it can in fact intercept but a small part of the southern current, which consequently to a large extent passes on south of the Cape; yet this small part produces the wonderful effects pointed out.*

* We find that at the recent meeting of the British Association, Mr. A. G. Findlay, in the course of a paper on the oceanic currents of the Atlantic and Pacific, takes the common view that the Lagulhas current is the origin of the current that flows up the West African coast, a view shown on page 322 to be untenable.

Suppose now, that by a change of level, America were to terminate in latitude 34° S., and Africa in latitude 56° S.: the relation of the two, and of the cold influences of the currents adjoining, would be entirely changed. The vast area in the South Pacific, embraced between the west South American coast and the isocryme of 74°,—which marks the influence in the colder season of the cold southern waters, though not by any means its extreme limit,—would, if transferred to the Atlantic equatorial regions, stretch nearly or quite across from Guinea to the East Cape of South America; and the line of 68° would sweep around north of the equator quite to mid-ocean. The actual extent of the change may be perceived with close accuracy if we transfer the isocrymal lines off this part of Western America to the Atlantic. In the Pacific, under the same circumstances, the line of 68° would nowhere reach within several degrees of the equator.

The distribution of marine life would be greatly changed. While now the west coast of South America is, as regards the ocean, one of the coldest regions for the latitude in the world, it would become very much moderated, and a considerable portion of coast would be bordered by tropical waters. Along by Lima, and far south, there might be coral reefs. In the Atlantic, on the contrary, the Gulf of Guinea now characterized by torrid waters, would be filled with the colder seas of the temperate zone, and true tropical life would be altogether excluded.

The influence also on the Gulf Stream would be very decided and the whole North Atlantic would feel the change.

It is a remarkable fact that while the west coast of America is bordered in the tropical part by cold waters, 10° to 12° below the mean of mid-ocean, and the marine zoology is hence extratropical, the temperature of the land is peculiarly torrid over the same latitudes. It is evident that in judging of the influence of the ocean temperature on the temperature of the land, the direction of the aerial currents for the year, should be considered as a most important element towards any just conclusions.

Although we cannot show that the supposed change of level in the continents has taken place, we may learn from the facts what vast changes in marine life, have happened in past ages, through such changes of level as have occurred in the earth's history. The changes on the land from this cause would be less marked; besides, these have had far less influence on the life of the rocks than those of the ocean, as the fossiliferous rocks are mainly of marine origin. We know that in the cretaceous and tertiary periods, the Andes were in part under water, or at a much lower level, and effects of the kind considered, cannot be altogether hypothetical.

Art. XLIII.—*Reviews and Records in Anatomy and Physiology;* by Waldo I. Burnett.

I. (1.) *Theorie der Befruchtung und über die Rolle, welche die Spermatozöiden dabei spielen;* von Dr. Th. Ludw. Wilhelm Bischoff, —in *Müller's* Arch. 1847. p. 422–443.

(2.) *On the Impregnation of the Ovum in the Amphibia, and the direct agency of the Spermatozoon;* (1st Series.) Philosophical Transactions, 1851, p. 169; (2nd Series revised.) Proceed. Royal Society, June 17, 1852; by George Newport, F.R.S., &c., &c.

(3.) *De Spermatozoorum introitu in ovula. Additamenta ad Physiologiam Generationis.* Auctore Gotth. Aug. Ferd. Keber, &c. Accedunt lxxxi figurae chalcotypicæ textui insertæ et in iv Tabulas collectæ. 4to, pp. 118. *Regiomonti Prussorum,* mdcccliii.

With every inquiring mind there is a deep interest connected with the development of animal life. To watch the origin and rise of new forms, to trace the successive phases through which they pass, as the ideas on which they are based become more and more definitely expressed, until finally the perfect animal is produced.—these have been favorite studies from the earliest times with some of the most genial minds, and over which they were accustomed to dwell with increasing delight. But more interesting still, because more wonderful, is the study of those necessary preliminaries of all individual development—the mysterious conditions of fecundation. To observe, after nature has prepared the material, how she puts up a new structure and to trace the adaptive idea in the laying of each part. require but opportunity united with careful diligence and patience. But to lift the veil beneath which lie hidden the more than mysterious relations of individuality, this is to tread on the confines which separate the material from the immaterial world.

There is no question in physiology so difficult and at the same time so interesting as—*How* is a new individuality started by the conjugation of the sexes: and where so little could be observed, there has been more scope for speculation.

In modern times, however, with certainly better instruments if not better opportunities, we have looked for less talk and more knowledge; and in this respect, it may be justly said that we have approached pretty near that boundary, which, as it is the limitation of that which can be perceived by the senses, is the real confine between the known and the unknown in physical science.

We have selected the above-cited works, because they comprise some of the most important recent contributions upon a subject we here propose to take up in a somewhat discursive manner. As it would be profitless to notice the labors of those numerous men,

who, in this department have written upon what they really knew nothing, yet speculated much, we shall attempt to show the state of our real knowledge on this *ultimatissimum* of physiology —the *modus operandi* of fecundation.

Modern histological studies, have we think, pretty definitely settled two fundamental and important points: 1st. That the ovum is, morphologically, only a nucleolated cell; and 2nd. That the sperm-cell is the true homologue of the ovum.

The ovum (fecundated) produces the embryo; the sperm-cell the spermatic particle. The embryo and the spermatic particle are the correlative representatives of the female and the male sex. One is the metamorphosed nucleus (vitellus) of the one; the other the metamorphosed nucleus (nucleus of the daughter-cell) of the other. In both, the ovum and sperm-cell, the process of segmentation seems a necessary preliminary to the evolution of the new being.*

The strict correlation between the essential products of the sexes is as wonderful as it is beautifully suggestive of the unity and simplicity of plan by which nature proceeds. This point, so seductive in all its relations, might be dwelt upon in detail, but we will continue with main and general facts. The ovum, as a nucleated or nucleolated cell, continues to grow, and whatever size it may attain to by the endogenous formation within its capsule of new cells, yet, when complete, it is, (even though belonging to the *Ostrich* or *Epiornis*,) morphologically, only a great compound nucleated or nucleolated cell. All these conditions of origin, growth and maturity, can be satisfactorily studied in the lower animals, and we would especially recommend the compound Ascidiæ for this purpose. The ovum, thus complete, is ready for fecundation.

We have already said that the sperm-cell is the analogue, or more properly *homologue*, of the ovum; its origin and development, as we have traced them in all their details, are precisely the same as those of the ovum. The sperm-cell increases to a definite size, its nucleus (vitellus) then regularly segments 2, 4, 8, 16, &c., and the results of this segmentation, are daughter-cells. The condition of the sperm-cell at this moment is like that of the ovum produced by the same process of segmentation. I mean the *mulberry-like* condition. But at this point there is a digression, for with the sperm-cell the nucleus of each of the daughter-cells is changed into a spermatic particle, while with the ovum, the whole mass is metamorphosed into the new being by a process of substitution.

The spermatic particle, then, is only a metamorphosed nucleus of a cell, and, perhaps, were the analogy carried out completely, each daughter-cell would be the representative of a miniature ovum.

* See Researches on the origin, mode of development. and nature of the spermatic particles among the four classes of the Vertebrata.—*Mem. Amer. Acad., N. S.*, v, *pt.* i, 1853.

Physiologically, the phenomena we have thus briefly described, obtain equally in the vegetable kingdom; for, as recent discoveries have shown, even in the simplest cellular plants there is a conjugation of two kinds of cells, the product of which terminates in a new generation; and in the other plants, the superior Cryptogamia, and the Phanerogamia, there are parts which in a developmental as well as a morphological point of view, correspond to the essential male and female products of animals.*

Throughout the organized world, therefore, the conditions which wait upon the true generative process are the same—the combination of the representative products of two distinct sexes—and these products, whatever may be said of their form, are always physiologically the same;—they are cells or cell-products.

Here we would make a general statement which embodies a great deal of physiology on this subject: A true generation must be regarded as resulting only from the conjugation of two opposite sexes, from a sexual process in which the potential representatives of two individuals are united for the elimination of one germ. The germ power thus produced may be extended by gemmation or by fission, but it can be formed only by the act of generation, and its play of extension and prolongation by budding or by division must always be within a certain cycle, and this cycle is recommenced by the act of the new conjugation of the sexes.

In this discussion, we have satisfactorily reached this point that the ovum and the spermatic particle are the potential representatives of the sexes to which they respectively belong. From their union results the condition of fecundation; the grand question now is, what is the *modus operandi* of this fecundating act? Here we touch upon debatable ground, and the three authors with which we have headed these remarks are the advocates of as many dissimilar views. Bischoff's view, based upon speculative probabilities rather than upon observation, is, that contact alone of the spermatic particle with the ovum being sufficient for fecundation, impregnation consists in a kind of catalysis which has its exemplification in chemical conditions as enunciated by Liebig, (see loc. cit., p. 425.) But if catalysis embodies conditions in the organic like those of its relations in the inorganic world, it falls very far short of affording the requisite explanation of these phenomena, as we hope soon to show. This field of probabilities and possibilities we shall enter upon again.

Newport's contributions upon the physical phenomena of this subject are far the most complete that we have, and being the results of a most trustworthy observer, they deserve our special attention. That his views may be the more clearly understood,

* We would refer to a profoundly physiological memoir by *Robin*, titled: "Ovum, its existence as well in the male as in the female of plants and animals," &c. Compt. Rend., 1849.

we quote his own language, as used in some of the conclusions which he has given. We will commence with the 5th, omitting the preceding four as irrelevant to our point in question:

"5th. That only extremely minute granules of solid matter can by any possibility pass into the tissue of the envelopes during endosmosis; and that there is no evidence whatever of the existence of a fissure or orifice, in the envelopes of the egg of the amphibia, at the time of, or before impregnation, capable of admitting the spermatozoon to the interior of the yolk-membrane or its contents.

"6th. That it is the spermatozoon alone which affects impregnation; and that this does not take place until the spermatozoon is brought into immediate contact with the external layer of the ovum.

"8th. That although direct contact of the spermatozoa with the ovum is indispensable to effect impregnation, I have never been able to detect any traces of these bodies in contact with the yolk-membrane, or even within the substance of the external envelope.*

"9th. That impregnation is *commenced* the instant the spermatozoa are brought into contact with the egg, but a certain *duration of contact* is essential to its completion.

"10th. That impregnation is not effected, when the whole or the majority of the spermatozoa in contact with the envelopes have previously become motionless, and apparently have lost vitality, as they are found to have done after the lapse of a longer or shorter period.

"11th. That although an exceedingly minute quantity of spermatozoa suffice to impregnate the ovum, the phenomenon of impregnation takes place more tardily even with duration of contact, when the number is extremely limited, than when it is in full abundance, without excess; while, when the quantity is deficient, or the duration of contact too limited, then the phenomenon is incomplete, and partial impregnation only is effected.

"12th. *Partial impregnation* is shown in imperfect segmentation of the yolk; and is due to the spermatozoa being insufficient in quantity, or in duration of contact, or inefficient through diminished vitality; and it may also result from diminished susceptibility in the ovum."

Newport's experiments and observations show, in brief, that contact alone of the spermatic particles with the ovum is requisite for fecundation, that each ovum requires several particles; and that there must be *duration* of this contact. Here is a limit to

* In his second series, Newport says he has detected the spermatic particles within the coverings of the egg, and sometimes even partially imbedded in the vitelline membrane beneath them;—but he had no evidence that they enter the vitelline cavity. We consider this fact of penetration within the envelopes as of no import in the question before us; for, as we hope to be able to show, it may well be regarded as contingent and not essential.

observation of physical facts, and we regard these important data worthy of full trust considering the source from which they come. This author discusses briefly the question of the nature of the impregnative power, and from the fact that the spermatic particles are sometimes seen to disappear on the surface of the egg-envelopes, he thinks it may be fair to conclude that the agency of this body is material in its operation; on the other hand, the fact of a mere *momentary contact* producing changes in the ovum, suggests in his mind the so-called catalytic power of certain known bodies. But he thinks that neither this last, nor endosmosis, are sufficient to account for the phenomena of this grand act.

The view of Keber, the last of the writers we have cited, has at least the merit of being unique if nothing more. As long ago as 1838, Martin Barry* announced that he had observed spermatic particles within the ovum. It should be mentioned however, that long previous to this, Prevost and Dumas† in their researches found these particles within the envelopes of the eggs of frogs. But Keber's alleged discovery is, that the introduction of the spermatic particles within the ovum, takes place through a special opening, a kind of micropyle, or an infundibuliform passage. This discovery was made upon the eggs of mussels (*Unio* and *Anodonta*), and that I may furnish a correct idea of its formation and relations, I will quote some of his conclusions. After describing the formation of the eggs and sperm of these animals, he proceeds:—

"3d. At the procreative season, there arises from the eggs, which are yet quite small, a bud-like process which projects from the albuminous membrane, and perforates the closely adjacent cortical membrane of the egg. This process bursts or dehisces, and there escapes from it a small quantity of albumen; it then receives a spermatic particle which has been introduced to the ovary in the usual way. This spermatic particle having thus been taken within the egg, the orifice of the micropyle closes up or becomes obliterated.

"4th. After this, and sometimes even before, the albuminous and vitelline membranes coalesce at the point of the micropyle; then the vitelline sac dehisces, and thereby the spermatic particle is received and enclosed in the very interior of the egg."—(p. 107.)

Upon this succeeds a description of the more or less minute changes which are alleged to supervene upon these processes, such as the disappearance of the micropyle, the disintegration of the spermatic particle, the singular changes of the vitellus which ensue, and the formation of a peculiar structure in the ovum for the ingress of the fecundating element—the spermatic particle, which finally reaches the very interior of the ovum and the germinative vesicle; but these need not detain us.

* *Barry*, Philos. Transact., 1840, pt. ii, p. 532.—1843, pt. i, p. 33.

† *Prevost* and *Dumas*, Ann. d. Sc. Nat., ii, p. 253.

The announcement of the presence of such a structure on the ovum is indeed wonderful, and more especally so since other observers, whose attention has been particularly directed to the embryological study of these animals, have failed to notice it, although one would suppose that an apparatus of this kind must be very visible. Keber affirms that he has observed a like structure in the ova of some other animals which he has examined. But, however well fortified he has sought to make his observations. they certainly need more than the usual confirmation, and we cannot but regard it as far from being a settled fact in embryology, that the ovum has a direct structural communication externally for the ingress of spermatic particles to its interior.

After all this discussion of facts, we revert to the primary question, what is the nature of the fecundating act? We have seen that its physical phenomena consist in the contact of active vital spermatic particles with the mature ovum; that this mature ovum, thus affected, experiences peculiar changes which terminate finally in the evolution of a new being possessing the characteristics of the male as well as of the female parent. It is true that, as was observed by Prevost and Dumas, and as has since been confirmed by Barry, Newport, and others, the spermatic particles may force their way through the envelopes of the egg some distance into its interior, but we regard this as an unessential condition of the fecundatory act; adhering by their heads to the envelopes of the egg, the incessant action of the tails of these bodies would obviously tend to force them inwards, and especially through such homogeneous, soft tissues as the egg-envelopes.

As a point of some importance in this connection, it may be mentioned, that there are cases where this intrusion of the spermatic particle into the interior of the ovum does not seem available from the very structure of the particle. Thus, with the Decapod Crustacea, these bodies consist each of a central nucleus to which are attached many long radiating processes; moreover, in these animals, the motion of the spermatic particles ceases so shortly after their escape from the body, that this entrance into the ovum would not be likely to be effected with even the most favorable perforating structure. It may also be here mentioned, that as motion is, with these particles, the only visible exponent of their vitality, it is highly probable that in these very same animals, the merest contact suffices to fecundate the ovum.

Even admitting the hypothesis of Keber and others, that the spermatic particle is mixed *de ipso* with the contents of the ovum, it would explain nothing, and would approximate us not in the least to the nature of this process, for it is just as comprehensible that the spermatic particle should fecundate by mere contact, as that it should by a material mixing or even an interpenetration of its constituents with those of the ovum.

By referring to the resultant phenomena of this fecundating process, we may perhaps gain some insight into the conditional if not the real nature of its agency. We have already said that the spermatic particle is the potential representative of the male; what signification is to be attached to its mere physical form, that is, whether it is conical, globular, &c., we know not; and this seems the more hidden from our perceptions, from the fact that exactly similar forms and sizes,—in fact, physical relations apparently identical—belong to spermatic particles of animals as widely dissimilar as could be. This fact alone, of the correctness of which we are well assured from our own observations, should be sufficient to convince us that we have here to deal with no very simple relations or properties. But let us pursue the subject a little further. I scarcely need remark, that the offspring partakes equally of the physical peculiarities of both parents. It will at once be perceived, that in no way can the child receive those of the father except through the medium of the spermatic particles. And so, however strange it may appear at first, yet the conclusion is irresistible that spermatic particles must contain, concealed within them, in fact must be the vehicles of, not only the general peculiarities of the father as an animal, but mental dispositions also, and as is too often true of our own species, morbid taints superadded to all. It is wholly insufficient to say with Bischoff, that these anomalous conditions belong to the catalytic action; or with Newport that they may be the exemplifications of a force, peculiar and *sui generis*. For there is something above and beyond the wakening of latent forces, of one particle that is positive with another that is negative. The grand fact is, that the act of fecundation includes—whatever may be said of its also vitalizing the ovum—the communication or the transmission of the *individuality* of the male parent to the ovum; and the material organ of this transmission is, exclusively, the spermatic particle. We cannot see that these phenomena have an adequate explanation in any chemical relations of matter yet known, and what is more, we cannot conceive the possibility of this ever being the case, unless, indeed, chemistry gets beyond the domain of physics. Not but that chemistry involves points which are equally obscure, such as affinity, isomorphism, &c., but then the conditions of vitality, and especially the grand manifestation of it in question, certainly seem to us to include relations which have no correlation whatever with those pertaining to inorganic matter. To us the relations and conditions of cells, which are the primordial forms of organization, demand the *teleological* view of organic life.* *Individuality* is the distinguishing feature of organization, and we recognize in it something more than a mere collocation of physical conditions; we

* See The Relations of Cells to the Physical and Teleological views of Organization, in this Journal, xv, 87, Jan., 1853.

regard it as an Idea which exists before organization, which last as only the language in which the Idea is expressed. The conditions of this process of fecundation which we have just reviewed, will accept no other explanation, say what physiologists may about the *unphysical* character of such a view; we must have something beyond mere *combination*, which lies with physics; this we have in *development*, which lies with life.

In conclusion, we may say, that as the domain of science lies with demonstrable phenomena, so its legitimate study is with the sensible and tangible. The conditions of immaterial agencies, and their relations with material forms, must be accepted as pure phenomena incapable of the analysis of ordinary scientific facts. But after all, how much more of an enigma is the process of fecundation than the essence, the primordial cause of everything connected with both the inorganic and organic world about us. Science should put out her long, tentacular arms in all directions, laying hold of the tangible and the sensible, but it should be remembered that the supra-sensible is beyond her pale, and that "*multa esse constant in corpore quorum vim rationemque perspicere nemo nisi Qui fecit potest.*"

II. *Mikroscopische Anatomie oder Gewebelehre des Menschen*; von Dr. A. KÖLLIKER, Professor der Anatomie und Physiologie in Wurtzburg. Zweiter Band: Specielle Gewebelehre.

Erste Hälfte; von der Haut, den Muskeln, Knochen und Nerven, mit 168 Holzschnitten, ausgefürht von J. G. FLEGEL, und vier lithographirten Tafeln.

Zweite Hälfte. 1. Abtheilung. Von den Verdaungs-und Respirations-Organen. Mit 127 Holzschnitten, ausgeführt von J. G. FLEGEL. 8vo, pp. 554, 346. *Leipzig*, 1850–52.

The writings of Kölliker already mark an episode in the history of physiological science. The department he has chosen, is *Structure*, in both its forming and its complete condition. This is a field which has been made worthy by the presence of most honorable names, who have marked it all over with intersecting lines which here and there stretch out beyond the ordinary boundaries, it is now so extended that it would, indeed, be meritorious to prove a faithful pilgrim in the paths of others in this wide domain. The merit and peculiarity of Kölliker is, that he has proved himself both a pilgrim and a pioneer, and while he has pushed exploringly upon hitherto untrodden ground, he has not, like many, been ignorant of what others before him have seen and done.

Of the work before us nothing has appeared like it, since the "Allgemeine Anatomie" of Henle, nearly twelve years ago, and the work of Henle was no more remarkable then, than that of Kölliker is now. Considering these two works, as we may, in a

measure, as corresponding books of their times, the difference in new matter or in newly developed points, as shown by an examination of the latter, is a satisfactory commentary on the progress of structural science during this brief period.

The second volume of the *Mikroskopische Anatomie* is published before the first, a mode of proceeding which we do not like, but which is becoming not uncommon abroad. It of course enables the investigator to put that portion of his labors before the world which have been finished, and so far is very good, but we question if the work, as complete, is not thereby delayed.

This second volume is devoted to special histology, and treats of the essential structure of the *skin;* or rather, more comprehensively, of the *cutaneous system*, of the *bones*, and the *nervous system;* these subjects are included in the first half. The first part of the second half, and all published that we have seen, treats of the digestive and respiratory organs; and when it is borne in mind that the histology of these two subjects occupies 900 pages, an idea will be entertained of the comprehensive manner in which they are taken up. The limits of our prescribed space make it wholly out of the question to review such a work, for each of its subjects presents enough of new matter originally brought out, for a special examination. We shall be well content if we succeed in noticing some of the more salient points in histology, here produced. It should, however, be first mentioned, that the mode in which Kölliker treats a subject is as comprehensive as it is different from that of any who have preceded him in works of this kind. In any given tissue, say, for instance, *muscle*, there are first described its peculiarities, general and intimate, as a tissue of its kind or genus; then follows the details of its structural analysis as species or varieties, from difference of location and perhaps special function; then its chemical and physical relations; then its comparative study with animals: then its development; then its pathology; and finally, its physiological relations and conditions. This relates of course to the simple histology of the tissue. But besides this, its vital relations are described, such as its innervation, its nutrition, and its connections with surrounding parts. You have then, Tissue: its structure, general, special, and comparative; its chemistry; its development: its pathology; and its physiology. The advantages of this mode of handling a subject of anatomy, aside from its comprehensiveness, must be apparent to all. I would here insist particularly upon the point of a comparative study of tissues in animals. Writers upon human anatomy and physiology have been too much inclined to treat the human subject with its details as though its physical relations to the inferior animals, were as dissimilar as those of its mind. They would seem to forget that, zoologically, man is an animal,

and therefore that his structures are but greater or less variations of the types of the classes beneath him. The truth is, human histology should never be studied until the student has passed through a course upon the lower animals; and all who have labored much upon the domain of structure know very well how the whole idea or plan of composition of a tissue has dawned upon them, by observing it in some of its simple and uncomplicated forms as occurring in an inferior animal. What is desired or aimed at, is the *formula* of a tissue. and this once being appreciated, can never be obscured or lost. whatever may be the language in which it is expressed. This statement obtains all the more force, from the unity and simplicity of plan pursued by nature, in the material forms through which her different organic conditions are manifested; thus, nervous tissue is the same, essentially, wherever found in the animal kingdom, whether in the plant-like polyp or in man. The same may be said of other tissues, and when the student of structure has fairly seized hold of such grand facts, he has proceeded not a little way on his course.

We cannot think of taking up any special portion of the work of Kölliker before us, not even in a general way, and quotations from so succinct a treatise would mar the sense and convey little meaning. Much, however, that is new and of special interest will be found under the head of *development* of each tissue or structure, for here Kölliker has shown himself particularly original and proficient. This is especially true of the nervous system, where there is a fullness of detail commensurate with the importance of the subject.

We look with more than ordinary interest for the appearance of the first volume of this encyclopædian work; but as it must comprise subjects which are yet hardly ripe for a satisfactory discussion, we would not ask its too early issue. We refer here to that debatable ground, *cells* and *cell doctrines*. Not satisfied, ourselves, of the universality of the application of Schwann's doctrines in this respect, and having, moreover, carefully traced the features of a new mode of cell-genesis essentially dissimilar from that of Schwann, there is some personal concern attached to this subject. But untied from any special theory, we shall be more than pleased if the distinguished Wurtzburg Professor is able to reconcile these dissimilar conditions of the science, and clearly show a single and universal mode of cell-genesis,—a unity, which, from the very correlative constitution of the human reason to the conditions of organization, the mind seeks and longs for in an earnest and almost prophetic manner.

Record of Anatomy and Physiology, Oct. 1, 1853.

SPECIAL WORKS.

Lectures on Surgical Pathology, delivered at the Royal College of Surgeons of England. By James Paget, F.R.S., &c. Vol. I. Hypertrophy: Atrophy: Repair: Inflammation: Mortification: Specific Diseases. Vol II. Tumors. *London*. 1853.

De Spermatozoorum introitu in Ovula: Additamenta ad Physiologiam Generationis. Auctore Gotth. Aug. Ferd. Keber, Medicinæ et Chirurgiæ Doctore, Regio physico Insterburgensi. Accedunt lxxxi figuræ chalcotypicæ textui insertæ et in IV Tabulas collectæ. *Regiomonti Prussorum*, MDCCCLIII. (In German also.)

Beiträge zur mikroskopischen Anatomie und Physiologie des Ganglien-Nervensystems des Menschen und der Wirbelthiere. Von Carl Axmann. Doctor der Medicin. Mit 22 in den Text eingedruckten Abbildungen. *Berlin*, 1853.

Abhandlungen aus den menlichen und vergleichenden Anatomie. Von Wenzel Gruber, Dr. Med. et Chir., &c. &c. Mit XI Tafeln. *St. Petersburg*, 1852.

Mémoire sur la structure intime du Foie et sur la nature de l'alteration connue sous le nom de Foie Gras, &c. &c. Par A. Lereboullet. Accompagné de quatre planches. *Paris*, 1853.

Rudolph Wagner's Icones physiologicæ. Erläuterungstafeln zur Physiologie und Entwickelungsgeschichte. Vollständig neu bearbeitet und herausgegeben von Alexander Ecker. Erste und zweite Lieferung. *Leipzig*, 1852.

[The first mentioned of these works will be found noticed in our reviews and the Bibliography of this number; and the last four deserve a special mention, for most of them are contributions to science of no ordinary character. That of Axmann (8vo. pp. 146), furnishes by far the most complete account we have of the microscopical structure of the ganglionic nervous system, and is well illustrated with numerous figures intercalated in the text.—The work by Gruber (4to. pp. 160), is composed of eight memoirs, the first seven of which relate to comparative osteology, and especially to some difficult points; the last memoir is upon human Myology, Angiology and Splanchnology, and the anatomist will be not a little surprised at the patient detail here shown. The whole is fully illustrated by 11 plates.—The work of Lereboullet (4to. pp. 117) is more important as bringing together in one work previous knowledge on the subject of the Liver, its structure and fatty degeneration, than as containing new facts. The essential ultimate structure, in fact the *formula*, of the liver is every where the same—that is cells which are the secreting organs. Fatty degeneration of the liver consists in these cells being loaded with fat globules. These two facts, long known in science, this author has brought out with much detail, as well also as the auxiliary hepatic structures.—What physiologist is not startled with pleasure at the announcement of *Icones physiologicæ*? A new edition of this renowned work is being published, and that too with appearances which would indicate that the hitherto enviable position of this work on physiological science, is not to be reduced even in these days of progress. Ecker, already well known in physiology, has undertaken this worthy yet difficult task. We have received the first and second Lieferungen as above announced; it contains twenty-seven plates, executed with surpassing beauty, which illustrate the Histology of the Splanchnic organs, of Muscle, of the Nervous System, of the Skin, of the Spermatic Particles, and of the Egg; then follows the Embryology of the Frog, and finally that of Man. It is now nearly thirteen years (in 1839) since the original *Icones* of Wagner made their appearance, and the illustrations then given were of such excellence, that they were copied so constantly as to lead to the omission of the acknowledgment of their source; and thus re-engraved, many of them as now seen in our works not bear a resemble but little, at least in truthful beauty, their fine original. We can confidently predict the same fate for the illustrations of this new edition. In future notices it will be both our pleasure and profit to refer to this excellent work.]

PERIODICAL LITERATURE AND TRANSACTIONS OF LEARNED SOCIETIES.

SIEBOLD & KÖLLIKER'S ZEITSCHRIFT FÜR WISSENSCHAFTLICHE ZOOLOGIE. Bd. V. Hft. 1. August, 1853.

Leydig, Zur Anatomie von Coccus hesperidum. p. 1.

Gegenbaur, Ueber die Entwickelung von Doliolum, der Scheibenquallen und von Sagitta. p. 13.

Hannover, Zur Anatomie und Physiologie der Retina. p. 17.
Filippi, Ueber eigenthümliche Organe der Mundschleimhaut des Elephanten. p. 26.
Hessling, Ueber Seitendrüsen der Spitzmäuse. p. 29.
Leydig, Histologische Bemerkungen über den Polypterus bichir. p. 40.
—— Ueber die Vater-pacinischen Körperchen der Taube. p. 75.
Corti, Histologische Untersuchungen angestellt an einem Elephantem. p. 87.
Aubert, Beiträge zur Entwickelungsgeschichte der Fische. p. 94.
Gegenbaur, Ueber einige niedere Seethiere. p. 103.
Kölliker, Einige Bemerkungen über die Pacinischen Körperchen. p. 118.

Müller's Archiv für Anatomie, Physiologie und wissenschaftliche Medicin, 1853. Heft. 2, July.

O. Kohlrausch, Ueber das Schwellgewebe an den Muscheln der Nasenschleimhaut.
—— Ueber so genannte Infarkten.
E. H. Weber, Widerlegung der von Volkmann gegen meine Abhandlungen über die Anwendung der Wellenlehre auf die Lehre vom Kreislaufe des Blutes und insbesondere auf die Pulslehre gemachten Einwendungen.
J. Müller, Ueber den Bau der Echinodermen.

Henle & Pfeufer's Zeitschrift für rationelle Medicin. Neue Folge, III. Heft. 1, 2, 3. 1852–53.

Everts, Ueber Epilepsie. p. 1.
Weber, Ueber Croup und Tracheotomie. p. 8.
Donders, Die Bewegung der Lungen und des Herzens bei der Respiration. p. 39.
Von Dusch, Tetanus traumaticus, Chloroformnarkose; Genesung. p. 53.
Darsy, Beiträge zur Anatomie der Muskeln und Bänder der Hand. p. 65.
Böhmer, Ueber die syphilitische Affection der Leber. p. 88.
Zeucker, Sarcine in der Lunge. p. 111.
Nuhn, Versuche an einem Enthaupteten nebst erläuternden Versuchen an Thieren. p. 129.
H. Meyer, Ueber krebsige Phlebitis. p. 136.
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Lowe, On the Reproduction of the Toad and Frog without the intermediate stage of Tadpole. (Mar. 10.)
Barry, On animal and vegetable fibre as originally composed of twin spiral filaments, in which every other structure has its origin, &c.
—— On the Penetration of the Spermatozoa into the interior of the Ovum; a Note showing this to have been recorded as an established fact in the Philos. Trans. for 1843. (Mar. 17.)
McDonald, Observations on the Anatomy of the Antennæ in a small species of Crustacean. (Apr. 7.)
Clark, On certain functions of the Spinal Cord. (Apr. 14.)
Neale, Researches on the distribution of the Blood-vessels, &c., in the lungs. (June 9.)
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J. Davy, On the eye of the Mole. p. 47. (Proceed. Zool. Soc.)
Lubbock, On two new species of Calanidæ, with observations on Spermatic tubes of Pontella, Diaptomus, &c. p. 115 and p. 154.
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ART. XLIV.—*Correspondence of M. J. Nicklès, dated Aug.* 20, 1853.

Reproduction of Cotton from Pyroxyline.—The following observation on the restoration of cotton from pyroxyline, was made by M. Béchamp, Professor at the School of Pharmacy at Strasburg. The process consists in heating pyroxyline, at the temperature of boiling water, with a concentrated solution of protochlorid of iron. The chlorid deepens in color and very soon there is a disengagement of pure nitric oxyd. When this disengagement has ceased, the process is ended, after washing the cotton with chlorohydric acid to remove the peroxyd of iron impregnating the cotton fibres.

By a similar method, M. Béchamp has succeeded in reproducing amidon from xyloidine, gum from nitric gum; and he has thus found a process which may be applied without doubt to many substances containing nitrogen in the state of NO_4.

Phenomena of Contact.—M. BERTHELOT, of whom we have spoken in our former contributions, and who has been engaged in some researches on forced dilatation, has undertaken the study of several points that have been much controverted. He has employed in his researches pressure aided by a high temperature. His apparatus and the observations he has made, may be useful in practical chemistry, and we propose to return to the subject in our next communication.

The following are some of his results:

1. Absolute alcohol heated in a closed vessel towards 360° C., along with *crystallized* chlorid of calcium, produces ether and olefiant gas. Cl Sr acts in the same way. Cl Ba and Cl Na he has under trial.

The chlorids hence act by contact, and not by removing the water of the alcohol, since they are used in the state of a crystallized hydrate.

2. Towards 400°, ClH NH_3 decompose alcohol, producing ether, a little olefiant gas, and chlorohydrate of ethylammine.

3. At 360° IH, AzN_3 acts in the same way: towards 400°, it decomposes ether into water and iodohydrate of ethylammine.

4. At 360°, wood-spirit, with crystallized Cl Ca gives methylic ether; with Cl H NH_3 at 300°, it affords methylic ether and chlorohydrate of methylammine.

5. Sugar heated to 100° C. with a little water is altered after some hours only in an insensible manner. With Cl Ca it changes to glucose. Cl Na does not act. ClH NH_3 produces rapidly this transformation.

6. Essence of turpentine in contact with acids at 100° C. is modified isomerically. Its rotatory power changes. This change takes place even when the acid is insoluble in this liquid, and enters into no combination. The essence of lemon with the acids at 100° C. undergoes a similar alteration.

The earthy chlorids and ClH NH_3, towards 240° C., act in an analogous manner on the essence of turpentine,

7. Fluorid of boron acts at the ordinary temperature. 1 part of gas (two vols.) transforms completely 160 parts of the turpentine without decomposition or evolution of gas. These changes are attended with a slight disengagement of heat.

Ammonia in Rain-water.—M. BOUSSINGAULT has been engaged for some time in investigating the proportions of ammonia in rain-water in the cities and country, taking Paris as one station, and for the other the old monastery of Liebfrauenberg, situated in the Department of the Lower Rhine on the eastern slope of the chain of the Vosges. The proportions of ammonia at Paris have varied from 1 to 5·45 milligrams, the mean, 3·35 milligrams per liter; while at Liebfrauenberg the rain-water contained hardly 1 milligram. Attributing the excess to emanations, Boussingault says, that Paris may be viewed as a vast mass of smoking chimneys—a comparison little flattering to a city which calls itself the "cerveau de l'univers."

Bronze for the Sheathing of Ships.—M. BOBIERRE, chemist at Nantes, who has studied this subject for some years, has arrived by his experiments, at the following conclusion: that by diminishing the proportion of tin the oxydizable metal is less uniform in its distribution through the plates, and there is a consequent inequality of alteration under the influence of seawater. His recent researches show that sheathing of bronze is preferable, as regards durability and solidity, to copper or brass. The abnormal alterations which have been observed are due to defective manufacture. The presence of arsenic does not occasion alteration in this alloy as happens for red copper. Bronze that will do good service contains in general 4·5 to 5·5 p. c. of tin; that with less, alters unequally. The introduction of a little zinc into these alloys of copper and tin, improves the product by favoring the diffusion of the positive constituent of the metallic mass.

Photography.—Several memoirs on photography have been addressed to the Academy. One of them relates to the cause of the partial reduction which the salts of silver experience in photographic operations, thereby damaging the results. M. Bertsch has recognized that these reductions are produced by hydrogen or its gaseous compounds, the presence of which cannot be easily avoided; a very small quantity suffices to produce a very evident effect on the bromids, chlorids and iodids of silver, even in perfect darkness. M. Bertsch mentions the remedy well known to chemists—the disengagement of some bubbles of chlorine gas in the place where the process is going on: this prevents these spontaneous reductions.

Other papers read before the Academy.—A note by M. Garnier completing his researches on the relation between the mean atomic weight of simple bodies and their specific heat, alluded to in the number for January.—A memoir of M. Carlet on Sebacic acid, discovered by M. Thenard, and obtained by M. Bouis by means of castor oil.—A note on the use of chlorine in analyses by MM. Rivot, Boudant and Daguin.—Memoirs of M. Payen and of M. Brame on marl beds and the effects of lime in agriculture.—Rules to be used in the administration of chloroform, by Dr. Baudens.—Notes of M. Favier, M. Bourdaloue, M. Breton de Champ, etc., on the levelling of the Isthmus of Suez; according to some, there is a considerable difference of level between the sea of Suez and that of Péluse, and according to others there is none at low tide. We wait for agreement between these inquirers. So also as to a discussion on the constitution of amids between MM. Gerhardt and Wurtz: we prefer to accept the facts and leave the method of interpretation of each to himself.

Galvanism.—A modification of Bunsen's battery is proposed by M. Guignet, consisting in replacing the nitric acid by a mixture of peroxyd of manganese and sulphuric acid. It is seen that the oxygen thus produced acts here the part of the nitric acid in burning the hydrogen proceeding from the decomposition of water. The process is recommended: but it is of too recent introduction to have been fairly tried.

M. Gautier communicates a fact of quite a different kind. He has obtained some sulphuric acid by exposing a mixture of air and sulphurous acid to the luminous arch produced by a powerful battery. To succeed, the points of the battery should be of platinum.

Dr. Amussat presents the results which he has obtained with the use of a galvanic battery in therapeutic surgery. With a platinum wire heated to a high temperature by means of a strong battery he has had complete success in the cauterization and removal of tumors. The wire should be incandescent, but must be used with caution, as at this temperature it is easily broken off.

Machine with Vapor of Ether.—The steamboat, Du Trembley, has an engine adapted for the use of the combined vapors of water and ether. The object of the ether is said to be to retain and utilise the heat lost by the steam, and employ it in forming a second vapor whose force shall be added to that of the steam.

The following is the process employed by Du Trembley, the inventor. The facts here given are from a report signed by an administrative commission which examined the invention during the first voyage made by the vessel between Marseilles and Algiers. The vessel is of a size to carry 100 passengers and 230 tons of merchandise.

In order not to lose the heat which the steam retains after employing its expansive force, M. Du Trembley receives the spent steam in a closed apparatus, consisting of a considerable number of small vertical cylinders placed close together, yet not in contact. The foot of these cylinders is plunged into a reservoir of ether placed under the apparatus which conveys the steam; the ether rises in the tubes, and in part fills them. When the steam has penetrated into the apparatus which traverses the tubes, and has surrounded them on all sides, the phenomenon mentioned above takes place; the water is condensed and the ether evaporates.

In condensing, the water produces a vacuum which adds to the expansive force of the steam in extinguishing the resistance which it had encountered; and the ether vapor, collected in a separate compartment in which the tubes terminate above the vaporizing apparatus, then contributes a new force which is added to that of the steam.

The condensed water is collected again in the boiler whence it had gone out as steam, carrying back as much heat as the ether had left after its vaporization.

The ether vapor which is collected above the vaporizer and the tubes in which it is formed, is taken into a cylinder specially adapted to it, but every way similar to that for the steam. The piston of the second cylinder can act either independently, or may connect with the same beam as that of the cylinder for the steam; in the latter case, the two vapors are combined in the same work, as takes place in the vessel Du Trembley, and which must always be the case in applying this system to navigation.

The ether vapor is treated like the steam: it passes into tubes like those of the vaporizer, where it is condensed by a continued jet of cold water which fills the apparatus and surrounds the tubes. The ether, again in the liquid state, is carried to the vaporizer, as the condensed water is restored to the boiler, to recommence the circuit just described.

Such is a brief description of the system of combined vapors adopted by Du Trembley. It may serve to explain the principle of his machine, and to show that compared with the ordinary steam engine, there will be a notable diminution in the fuel required.

In the course of the trials, the commission made four experiments on the quantity of coal expended. Together, these trials continued through 36 hours 50 minutes. They were made under different conditions as to weather; and whatever the winds, whether the ship was propelled by the engine alone, or by this with sails, the force of the engine was nearly constant at about 70 horses. The quantity of coal consumed during the $36^h\ 50^m$ was 2860·9 kil., or 77·67 k. per hour, and 1·11 k. per horse power.

Before using the *combined* vapors, the vessel was navigated with steam alone, under the same pressure, acting on the two cylinders. The amount of coal consumed during 28·18 hours, was 8519·5 k., or 302 k. per hour, and 4·31 to 4·51 per horse power.

The Report observes: "D'après ce calcul, on serait arrivé, par l'introduction de la vapeur de l'éther, à une économie de charbon sur la quantité dépensée quand les deux cylinders marchaient par la seule vapeur d'eau, de 3 kil. ·20 à 3 kil. ·38 par heure et par force de cheval ou de 74 kil. (26 p. 100), résultat si beau que nous osons à peine y croire, malgré que l'exactitude des chiffres sur lesquels nos calculs sont basés, nous soit de nouveau affirmée et qu'il diffère peu de celui que nous donnent nos propre experience."

As to the dangers attending the use of ether, they are neither more nor less than those inherent in the employment of illuminating gas, and as such reasons have not prevailed against this mode of illumination, they cannot prevail against an invention which has the advantage of actual and great economy.

As the ether is not lost during the work, the expense of it is small. It was the greatest difficulty encountered, so to close exactly the joints, as to allow of no escape of the subtle and inflammable vapor. But "this has been accomplished with such precision, that we can affirm," says the commission, "that if a slight odor of ether is perceived when the machine is heated up before starting, it disappears entirely after the ship is in motion."

Locomotion with the Vapor of Chloroform.—Chloroform has been used in place of ether in an engine somewhat similar to that of Du Trembley's. The experiments have been made in the Orient, on a steam vessel of 120 horse power, called the Galilee. They profited by the presence of the minister of marine, to run the vessel about the harbor in all directions. The details of the construction of the machine have not yet been made known. But after the above description of the ether engine, we may conceive that it is nearly the same thing. They speak of an economy of fuel of 50 p. c. with the chloroform engine.

Pisciculture.—The government of the Pays-Bas has instituted a commission for establishing in Holland some Piscines after Millet's system. A Piscine will be installed in the palace of the Voos in Guelder, another in the palace ("du bois") at the Hague. The commission will publish also a manual containing all the theoretical and practical data to insure good management and successful operations. The preparation of this manual is already far advanced.

Prizes Proposed.—The Société d'Encouragement, of which M. Dumas is president, proposes to issue the following prizes:—

1. A prize of 3000 fr. to the author of the best work on the nature of the disease which attacks the vine.

2. A prize of 3000 fr. to the inventor of the most effectual method of preventing or destroying the disease of the vine.

3. Three prizes of 1000 fr. each, and six of 500 fr. each, in favor of authors of the best works on the following subjects.

(1.) Origin and progress of the disease: the work to be accompanied by charts illustrating the annual progress.

(2.) Discovery of a method of sowing at will the Oidium or of inoculating it.

(3.) Discovery of the conditions of hybernation peculiar to the Oidium.

(4.) An exact history, accompanied with authentic proofs of the effects obtained from the use of different manures, and especially the sulphurous.

(5.) Variations in the disease due to climates, exposures, soils, and meteorological circumstances.

(6.) Historical account, accompanied with authentic documents, of the effects, positive or negative, obtained from the different remedies proposed and hitherto employed.

(7.) Research on the effects produced on the vine towards removing the disease by plants or trees in their vicinity, and especially those which are rich in volatile oils, or which inhale a strong odor.

(8.) Invention of apparatus convenient of use, for throwing different water solutions or powders on the vine.

(9.) Indications of the measures which may be prescribed by authority for preserving the green-houses, and even whole vineyards from the ravages of the disease.

The society at the same time issues a list of the different works which have been published on this subject, and will distribute all these documents gratuitously.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *New Bases containing Palladium.*—The chlorid of palladium, Pd Cl, forms with ammonia, as is well known, two compounds which have the same constitution but which differ strikingly in color, the one being dark rose-red, the other yellow. These compounds have been studied by Vauquelin, Kane, Fehling, and Fischer, and found to be represented by the formula Pd Cl+NH$_3$, but their true nature has remained unknown. Müller has given the subject a careful investigation

in Wöhler's laboratory and has arrived at the conclusion that the yellow salt is the chlorid of an ammonium in which one equivalent of hydrogen is replaced by one equivalent of palladium, and is consequently represented by the formula NH_3Pd, Cl. Müller terms the new radical NH_3Pd, *palladamin* which we shall however venture to change to *palladammonium*, corresponding to methyl ammonium, platin ammonium, &c. The oxyd of palladammonium is readily obtained by diffusing the chlorid through water and adding oxyd of silver, or by precipitating a solution of the sulphate by hydrate of baryta. In this manner a pale yellow strongly alkaline solution is obtained, which, when evaporated over sulphuric acid, yields a solid distinctly crystalline substance which is the oxyd NH_3Pd, O, and which may be redissolved without decomposition. The oxyd in solution absorbs carbonic acid rapidly from the air; it precipitates the salts of silver and copper, but dissolves no traces of the oxyds thrown down. When gently heated with a solution of sal-ammoniac, ammonia is given off, but on boiling, a new base is formed. With other ammoniacal salts the oxyd of palladammonium exhibits similar reactions, and it is therefore a stronger base than the oxyd of ammonium.

The salts of palladammonium are most easily prepared by decomposing the corresponding silver salts with the yellow chlorid. The author describes the carbonate, sulphate, and sulphite; they are all anhydrous; the two former are in yellow octahedra. The nitrate of palladammonium exists only in solution and is very unstable. The iodid of the new ammonium may be obtained in dark violet octahedra; the bromid strongly resembles the chlorid and gives yellow octahedra; like the chlorid these two compounds are anhydrous.

When the salts of palladammonium are treated with an excess of ammonia they pass into the salts of a second base corresponding in constitution to Reiset's platinum base and represented by the formula $2NH_3, Pd$. The author terms this base *palladdiamin*, but we shall call it *palladdiammonium*, as the termination *amin* has hitherto been applied only to ammonias and not to ammoniums. It may be considered as ammonium in which one equivalent of hydrogen is replaced by one of palladium, while a second equivalent of hydrogen is replaced by one of ammonium, the formula being $NH_2(NH_4)Pd$. The chlorid of this radical had already been obtained by Fehling in colorless prismatic crystals. Müller obtained the oxyd by precipitating the sulphate with hydrate of baryta; in this manner a pale yellow strongly alkaline solution was obtained, which by evaporation yielded a crystalline mass. The solution precipitates the salts of copper, iron, cobalt, nickel and alumina but not those of silver: it expels ammonia from a boiling solution of sal-ammoniac, absorbs carbonic acid from the atmosphere and forms salts when saturated in the cold with acids. An excess of acid, however, particularly when heat is applied, resolves the compounds of palladiammonium into ammonia and palladammonium. The author describes the chlorid, iodid, bromid and fluorid of this second radical, as well as the carbonate, sulphate and sulphite; all the salts are colorless and crystalline. Attempts to prepare a urea in which one-fourth of the hydrogen should be replaced by palladium, proved unsuccessful. By substituting ethylamin for ammonia, Müller obtained new bases, the chlorids of which were represented by the formulas $NH_2(C_4H_5)Pd.Cl$,

$NH_2(C_4H_8N)Pd.Cl$, and $NH(C_4H_5)(C_4H_8N)Pd.Cl$. An anilin compound corresponding to the first of these was also obtained; its chlorid is represented by $NH_2(C_{12}H_7)Pd.Cl$.—*Ann. der Chemie und Pharmacie*, lxxxvi, 341.

2. *Anthranilic and Benzoic Acids.*—Gerland has instituted an accurate comparison of these acids, which together with a third acid discovered by Chancel, are represented by the formula $C_{14}H_6NO_3+HO$. The results of this investigation are as follows.

(1.) Anthranilic acid is the true carbanilidic acid constituted similarly to carbonic acid and represented by the rational formula CO_2, $CO(NH.C_{12}H_5)+HO$.

(2.) Anthranilic acid is different from benzamic acid and from the acid termed by Chancel carbanilidic acid.

(3.) Benzamic acid $C_{14}H_4(NH_2)O_3+HO$ is identical with Chancel's carbanilidic acid.

(4.) Nitrous acid NO_3 converts anthranilic acid completely into salycylic acid; the equation is $C_{14}H_6NO_3, HO+NO_3=C_{14}H_5O_5, HO+2N+HO$.—*Ann. der Chem. und Pharmacie*, lxxxvi, 143.

3. *New Compounds of Iridium.*—Skoblikoff has discovered a class of ammoniacal compounds of iridium which exhibit a perfect analogy to the well known platinum bases of Gros and Reiset. The investigation was conducted in the laboratory of Woskressensky, and led to the following results. Protochlorid of iridium treated with carbonate of ammonia dissolves readily, and gives a greenish yellow, highly alkaline liquid, from which acids when added in very small excess, precipitate a yellow substance having the formula NH_3IrCl, and corresponding to the green salt of Magnus. Treated with hot nitric acid this substance yields a new salt which may be obtained in yellowish brilliant leafy crystals, represented by the formula $IrClN_2H_6O, NO_5$, and containing therefore a base exactly corresponding to Gros's platinum base, $PtClN_2H_6O$. The sulphate of this base crystallizes in fine greenish needles: the chlorid of the radical crystallizes in regular violet prisms, and is represented by $IrClN_2H_6, Cl$. By the action of dilute sulphuric acid upon the chlorid NH_3Ir, Cl yellowish orange leafy crystals are obtained which contain no chlorine, and are the sulphate of a base corresponding to platinammonium and palladammonium; their formula is NH_3IrO, SO_3 and the base may be called iridammonium. By boiling the chlorid of iridammonium with an excess of ammonia, a whitish substance is obtained which is the chlorid of a new base corresponding to Reiset's platinum base, and having the formula $N_2H_6.IrCl$ or $NH_2(NH_4)IrCl$. The author obtained a crystalline sulphate and nitrate of this base, having the formulas $NH_2(NH_4)IrO, SO_3$ and $NH_2(NH_4)IrO, NO_5$. The perfect parallelism between these bases, and those containing platinum and palladium is very interesting, and it is to be hoped that rhodium, ruthenium, and osmium will be studied from the same point of view.—*Journal für prakt. Chemie*, 58, 31.

4. *On Zirconia.*—In Katapleiite, a new mineral from Norway, Sjögren found an earth, the properties of which in general, corresponded with those of zirconia, but differed in the single particular, that the supposed new earth was easily soluble in an excess of oxalic acid. Berlin has investigated the subject carefully, and found that, contrary to the statements in all the text-books, the zirconia from the Frederichsvärn,

Expailly, Ural, East Indian, and Ceylon zircons is also easily soluble in oxalic acid, and that ammonia precipitates from the solution the hydrate of zirconia. The oxalate dried at 100°, has the formula $Zr_2O_3,2C_2O_3 + HO$, and is readily soluble in an excess of oxalate of ammonia. It is worthy of remark, that the precipitated hydrate of zirconia when long washed upon a filter absorbs so much carbonic acid from the air, that it effervesces when dissolved in acids. Berlin found the zirconia from Katapleiite, and from the Frederichsvärn zircon to have a density 4·9. He further states, that he did not succeed in separating zirconia into several earths, by the method of partial precipitations employed by Svanberg; the precipitates also contained the same amount of fixed base, and hence the equivalents of the different earths, if we admit the existence of more than one, must be the same.—*Journal für praktische Chemie*, **57**, 145.

5. *On Didymium.*—Marignac has communicated a memoir on didymium, and its principal combinations. The author effects the separation of didymium from lanthanum by the method of Mosander, that is to say, by the crystallization of the sulphates. It was found however, that the process could be facilitated by first dissolving the oxyds in a large excess of nitric acid, and then successively adding small quantities of oxalic acid. The first precipitates are more deeply rose-colored, and more rich in didymium than the subsequent ones, and after converting the oxalates into sulphates, the separation of these last by crystallization is effected much more rapidly when one of the oxyds is present in much larger proportion than the other. The equivalent of didymium was determined at first by the analysis of its sulphate by means of chlorid of barium: it was found however, that the sulphate of baryta obstinately retained a portion of the sulphate of didymium from which it could not be freed by washing. The determination of the oxyd of didymium in a known weight of the sulphate, gave as a mean of five determinations 698·2 for the equivalent of the oxyd; the analysis of the chlorid gave the number 700·2 as a mean of these experiments, and the author adopts 600 as the equivalent of the metal. Metallic didymium was prepared, by heating the chlorid with potassium. A greyish powder was obtained, which in cold water disengaged bubbles of hydrogen; the particles of metal burned with vivid sparks when projected into the flame of a lamp. Two small fused grains of metal were also obtained, which had an iron grey color, and brilliant metallic fracture, tarnishing rapidly on exposure; they did not decompose cold water, but were rapidly dissolved by acids with a disengagement of hydrogen. The protoxyd of didymium is the only base which this metal forms with oxygen; it is easily prepared by igniting the nitrate, carbonate, or oxalate, and after strong calcination, is perfectly white, and is not peroxydized by moderate heating in the air, or by fusion with nitre. Addition of nitric acid however, and subsequent moderate ignition, produce a dark brown superoxyd, which again becomes white on stronger heating. The protoxyd is a strong base; it dissolves readily in dilute acids with a considerable elevation of temperature, and rapidly attracts carbonic acid from the air. It expels ammonia from its salts when boiled with them; but water slowly converts it into a hydrate. The hydrate as obtained by precipitation with potash, has a very pale rose color, and resembles alumina: the

salts of didymium have a pure rose or a faint violet color. The author describes a sulphid and an oxysulphid DiS and DiS+2DiO. The chlorid has the formula DiCl+4HO; it has a pale rose color, is deliquescent, very soluble in water and alcohol, and crystallizes in large oblique rhombic prisms; the solution cannot be evaporated to dryness without losing chlorhydric acid. The nitrate of didymium is anhydrous and deliquescent; the carbonate is a pale rose-colored powder, and is represented by the formula $DiO.CO_2+2HO$: the sulphite is also insoluble and has the formula DiO,SO_2+2HO. The sulphate has the unusual formula $3(DiO,SO_3)+8HO$; there is also a basic sulphate represented by the formula $3DiO,SO_3$. The double sulphates of didymium and ammonium, potash, and soda, are respectively represented by the formulas $NH_4O,SO_3+3(DiO,SO_3)+8HO$, $KO,SO_3+3(DiO,SO_3)$, and $NaO,SO_3+3(DiO,SO_3)$; they are pale rose-colored, very slightly soluble precipitates. The oxalate is completely insoluble in water, and almost insoluble in oxalic acid, and very dilute mineral acids; it contains four equivalents of water. The author thinks the didymium compounds analyzed by him, might possibly have contained traces of lanthanum, as the peroxydation of the protoxyd produces no sensible change in its weight.—*Ann. de Chemie et de Physique*, xxxviii, 148.

6. *Regeneration of Hippuric Acid.*—Dessaignes has succeeded in reproducing the hippuric acid from benzoic acid and glycosin, by causing the oxychlorid of benzoyl, to act upon glycosin-zinc oxyd. The reaction is represented by the equation

$$C_4H_5NO_4,ZnO+C_{14}H_5O_2Cl=C_{18}H_9NO_6+ZnCl+HO.$$

[This most beautiful result opens a new field of investigation, and promises to furnish us with a series of acids homologous with hippuric acid, since we have already two homologues of glycosin, alanin and leucin, and two of benzoic acid, namely, toluic and cuminic acids. The oxychlorids of the acetyl series should give a parallel series of new acids. —W. G.]—*Comptes Rendus*, xxxvii, 251.

7. *On the Alkaloids of the Quinquinas.*—Pasteur has studied the action of heat upon cinchonine and quinine, and has arrived at results of great interest. When sulphate of cinchonine is moistened with a little water and sulphuric acid and then heated, it fuses and remains fused even after the expulsion of all the water. If the fused salt be kept for three or four hours at a temperature of from 120° to 130° C., it is completely converted into the sulphate of a new base which the author calls *cinchonicine*, and which though entirely distinct from cinchonine, is isomeric with it. The sulphate of quinine treated in the same manner, yields another new base isomeric with quinine, and which the author terms *quinicine*. Pasteur has furthermore shown, that commercial quinidine is a mixture of two distinct bases, *quinidine* and *cinchonidine*, also isomeric with quinine and cinchonine, and like these yielding by heat quinicine and cinchonine. Quinine deviates the plane of polarization to the left, quinidine to the right, and both deviate it to a considerable extent. Quinicine deviates the plane of polarization to the right, but very feebly when compared with the other two. The same is true for the other three bases. The author suggests that the

molecule of quinine is double, and composed of two active molecules, one of which deviates strongly to the left, the other feebly to the right. When heat is applied, the sinistrorsal molecule becomes inactive, while the dextrorsal molecule resists the action of heat, and thus the new molecule of quinicine deviates feebly to the right. Quinidine on this view, consists also of two molecules, both of which are dentrorsal, but one much more powerfully than the other. Heat renders this component inactive, and the result is then the same as before quinicine is produced. Precisely the same explanation applies in the case of cinchonine and cinchonidine which both yield cinchonicine. Pasteur concludes, by stating that quinoidine is always the p oduct of an alteration of the alkaloids, and that its formation may probably be entirely prevented by drying the bark after it is stripped from the tree in the dark. This would very greatly increase the product of quinine.—*Comptes Rendus*, xxxvii, 110, July 25th, 1853.

8. *Transformation of Tartaric acids into Racemic acid.*—Pasteur has found that when tartrate of cinchonine is submitted to a gradually increasing temperature, it is at first converted into tartrate of cinchonicine ; at a higher temperature the cinchonicine becomes quinoidine, while after an exposure of five or six hours at a temperature of 170°, the tartaric acid is in a great measure converted into racemic acid. The author considers that in this case the principal part played by the alkaloid, is to give stability to the tartaric acid, and enable it to support a high temperature without decomposition. Tartrate of ethyl which supports a high temperature without change, also yields a considerable quantity of racemic acid by heating. The racemic acid thus obtained artificially, is both physically and chemically identical with the natural acid, and may like this be split into dextro-tartaric and levo-tartaric acids. The levo-tartaric acid in combination with cinchonicine may also be transformed into racemic acid (common tartaric acid is dextrorsal.) After the separation of the racemic acid from the quinoidine, by precipitating it with chlorid of calcium, the filtrate from the racemate of lime deposits, after twenty-four hours, a salt of lime which contains a new species of tartaric acid easily obtained in fine crystals. This new species of tartaric acid exerts no action on polarized light, and cannot be split into levo-tartaric and dextro-tartaric acids. It differs therefore entirely from racemic acid. Pasteur has further found that it is possible to separate racemic acid into the two tartaric acids, by concentrating a solution of the racemate of cinchonicine to a certain point, when the levo-tartrate of the base crystallizes out. In the case of the racemate of quinicine the dextro-tartrate crystallizes first. The author throws out many ingenious suggestions, for which however, we must refer to the original paper.—*Comptes Rendus*, xxxvii, 162.

9. ***Levo-camphoric and Deatro-camphoric acids.***—Chautard and Dessaignes about a year since obtained a variety of camphor which deviated the plane of polarization to the left instead of the right, like ordinary camphor. On treating this camphor with nitric acid. Chautard obtained a new species of camphoric acid, which turns the plane of polarization precisely as much to the left as ordinary camphoric acid turns it to the right. The two acids—levo-camphoric and dextro-camphoric—resemble each other very strongly in chemical and physical properties. Equal

weights of the two acids brought into contact with each other immediately combine, forming a new acid which is altogether distinct from its two components, and which has no action on polarized light. The two camphors from which the two species of camphoric acid are derived, have also the same solubility, the same point of fusion and of volatilization, and the same power of rotation though in opposite directions. (It is not stated whether they unite to form a third and inactive camphor.) Pasteur has confirmed these results of Chautard.—*Comptes Rendus*, xxxvii, 166.

10. *On the Color of the Salts of Manganese.*—Gorgeu has at length settled the much disputed question of the cause of the pink color of the salts of the manganese, by proving that pure salts of protoxyd of manganese have always this color, and that the so-called colorless salts of this metal are in reality produced by the admixture of small quantities of the salts of other metals having the complementary green color. By boiling a solution of manganese with freshly precipitated and washed sulphid of manganese, iron, cobalt, nickel and copper are perfectly separated as sulphids, while an equivalent quantity of manganese is dissolved; the filtered solution gives crystals of a pink or rose-colored salt, yielding a pure flesh red precipitate with sulphid of ammonium. The author found that concentrated solutions of manganese are easily rendered colorless by the addition of small quantities of solutions of iron, nickel or copper: the decolorization is complete when the quantity of nickel is about $\frac{8}{1000}$ of the quantity of manganese; iron must be added in the proportion of $\frac{40}{1000}$, and copper in that of $\frac{1}{1000}$, to produce a colorless solution, but in this last case, the solution in mass has a faint violet hue. The insoluble salts of manganese are white in powder, but rose-red when crystalline.—*Comptes Rendus*, xxxvi, 861. W. G.

11. *Note to Dr. Smith's paper on the Decomposition of Chlorids by nitric acid*, p. 373.—Dr. Smith's observation that the alkaline chlorids are decomposed by heating and evaporating with nitric acid is not new, although I am not aware that the fact has ever been published. Mr. H. Wurtz made experiments on the subject in my laboratory two years since, and obtained the same results as Dr. Smith. The complete decomposition of chlorid of magnesium by evaporation with nitric acid, was also observed in the laboratory of the late Prof. Norton, a year or two I believe before Mr. Wurtz studied the subject. The alkaline nitrates are easily converted into chlorids, by boiling them with an excess of chlorhydric acid, in presence of any metallic oxyd having a strong affinity of oxygen. I employ the protochlorid of tin for this purpose, and when the reaction is over, and gas (nitrous oxyd) is no longer evolved, a current of sulphydric acid gas removes the tin, and the filtrate contains only the alkaline chlorid and free chlorhydric acid.—W. G.

12. *On the Chemical Action of the Solar Radiations*; by Mr. R. Hunt, (Proc. Brit. Assoc., 1853, Athen., 1100.)—This was a report to the section of the continuation of an examination of the chemical action of the rays of the prismatic spectrum, after it had been subjected to the absorptive influences of different colored media. The mode of examination adopted has been to obtain well-defined spectra of a beam of light passing through a fine vertical slit in a steel plate by prisms of flint and crown glass and of quartz. The spectrum being concentrated

by a lens, was received upon a white tablet and submitted to careful admeasurement; the colored screen (sometimes colored glass and sometimes colored fluid) was then interposed, and the alterations in the chromatic image was carefully noted; the chemical preparation was then placed upon the tablet, and the chemical impression obtained. The relation which this image bore to the luminous image was a true representation of the connexion between the color of a ray, and its power to produce chemical change. In the report made to the Belfast Meeting of the British Association the results of experiments made upon glass tablets prepared by the so-called collodion process were alone given. In the present report the examination has been extended to the photographic preparation known as the calotype, and iodid and bromid of silver in their pure states and when excited by gallic acid. M. Edmond Becquerel, in a paper communicated to the Academy of Sciences, of which an abstract appears in the *Comptes Rendus*, tom. xvii, p. 833, states "that when any part of the luminous spectrum is absorbed or destroyed by any substance whatever, the part of the chemical rays of the same refrangibility is equally destroyed." The author's experiments, as recorded in the former report and those now detailed, prove that this conclusion has been formed too hastily. Although there are many absorptive media which, at the same time as they obliterate a particular colored ray, destroy the chemical action of that portion of the spectrum, yet there are a still more extensive series which prevent the passage of a ray of given refrangibility, and do not at the same time, obstruct those rays which are chemically active of the same degree of refrangibility. This is particularly exemplified in the case of glasses colored yellow by different preparations. With some of these the blue rays are obliterated, the chemical action of this part of the spectrum not being interrupted, whereas in some other examples those rays permeate the glass, but are almost entirely deprived of chemical power. A still more curious fact is noticed in this report, for the first time, of some media which have the power, as it were of developing chemical action in a particular part of the spectrum where the rays did not appear previously to possess this power. Several glasses exhibited this phenomenon to a certain extent, particularly such as were stained yellow by the oxyd of silver; but one glass showed this in a remarkable manner. This glass was yellow when viewed by transmitted light, but it reflected pale blue light from one of its surfaces; it obliterated the more refrangible rays down to the green, and rendered the yellow rays far less luminous than usual. In nearly every case the yellow rays are found to be not merely inactive, chemically, but to actively prevent chemical action. After the spectrum has been submitted to the action of this glass, *all chemical power is confined to this yellow ray.* The author has hitherto supported the view that photographic phenomena and the illuminating power of the sunbeam were distinct principles, united only in their modes of motion. He was led to this from observing that where there was the most light there was the least power of producing chemical change; and that as illuminating power diminished, the chemical phenomena of the solar rays increased. The results, however, which he has obtained during the brief sunshine of the present summer, leads him to hold that opinion in suspension. In many of the

spectra obtained (copies of which will be appended to the printed report) there appears to be evidence of the conversion of one form of force into another—the change, indeed, of *light* into *actinism* or chemical power; and, again, as in Mr. Stokes's experiments, the exhibition of the ordinarily invisible chemical rays in the form of *light*.

Prof. Stokes offered some remarks upon the different effects produced by the spectrum, dividing them into luminous effect, chemical action, calorific power, phosphorescence, and fluorescence. These were different effects resulting from the same cause, and he did not consider that sufficient evidence had yet been given to warrant the idea that there existed any dissimilar agencies in the solar rays.—Prof. Johnston, the Rev. V. Harcourt, Dr. Daubeny, Mr. Claudet, and others, took part in the conversation which followed.

12. *Magnetical Investigations*; by the Rev. Wm. Scoresby, D.D., F.R.S., L. and E., &c. Vol. ii, 448, pp. 8vo, with illustrations. London, 1852. Longman, Brown, Green and Longmans.—The special subject of this volume by Dr. Scoresby, is Terrestrial Induction, and in its elucidation which is elaborately carried out, the author has had in view as one object, its bearing on the navigation of iron ships. The world is indebted to Dr. Scoresby for great improvements in compass needles and other magnetic apparatus, and not less for his elaborate researches. The work treats, (1.) of General views of Magnetical Phenomena, and of the Earth's Inductive Action, illustrated with figures; (2.) of the action of terrestrial magnetism on iron and steel of different kinds, and on iron and steel of various proportions as to surface and mass; (3.) on the effects of percussion, etc., in aiding, modifying and neutralizing the inductive influence of the earth's magnetism; (4.) on the development of magnetical properties by percussion in steel and iron, as aided by contact with iron bars previously magnetized by hammering; (5.) indications explanatory of certain peculiar magnetic phenomena, derived from the foregoing results; (6.) on the application of principles affecting the magnetical condition of iron, to its real and thorough neutralization. Then the author enters upon the subject of the magnetism of iron-built ships, with relation to the action of the compass, and the changes to which their magnetic condition is liable, which is treated at length, with a consideration of all essential and many incidental circumstances.

13. H. W. Dove: Darstellung der Farbenlehre und optische Studien; 288 pp. 8vo, with 2 lithog. tables. *Berlin*, 1853.

II. Geology and Palæontology.

1. *Ueber die Vulkanischen Gesteine in Sicilien und Island, und ihre submarine Umbildung* von W. Sartorius von Waltershausen. 532 pp. 8vo. *Göttingen*, 1853.—This work by von Waltershausen is an elaborate discussion of the minerals and rocks of volcanic regions, especially those of Sicily and Iceland. The consideration of the chemical relations of the several species of the feldspar group occupy nearly 100 pages of the work (pp. 16–105). Other minerals are taken up in order and also the rocks, and many new analyses are given. The volume exhibits elaborate research throughout.

2. Statistique géologique, minéralogique, métallurgique et paléontologique du departement de la Meuse ; par AMAND BUVIGNIER. 1 vol. 8vo, and atlas in folio. *Paris*, 1852.

3. Die geognostischen und orographischen Verhältnisse des nördlichen Persiens. Von Dr. C. GREWINGK. *St. Petersburg*, 1853. 8vo.

4. Untersuchungen über das Mainzer Tertiärbecken u. dessen Stellung im geologischen Systeme. Von Dr. FRIDOLIN SANDBERGER. *Wiesbaden*, 1853. 8vo.

5. Apunti sulla Geologia del Piemonte di BARTOLOMEO GASTALDI. *Torino*, 1853. 4to.

6. Zwei geologische Vorträge. Von Osw. HEER u. A. ESCHER von der LINTH. (1. Insects of the Lias. 2. Erratics of Switzerland.) *Zurich*, 1852. 4to.

7. Introduction philosophique à l'étude de la Géologie ; par A. GAUTIER. *Paris*, 1853. 8vo.

8. Geognostiche Beschreibung des Siebengebirges am Rhein. Von Dr. H. v. DECHEN. *Bonn*, 1852. 8vo.

9. Description géologique et minéralogique du département du Bas-Rhin. Par M. A. DAUBRÉE. *Strasbourg*, 1852. 8vo.

10. Systematische Beschreibung und Abbildung der Versteinerungen des rheinischen Schichtensystems in Nassau. Von Dr. GUIDO und FRIDOLIN SANDBERGER. 5th No., folio. *Wiesbaden*, 1853.

11. Die Versteinerungen der Grauwackenformation in Sachsen, etc. Von HANNS BRUNO GEINITZ. 2d No. 4to. *Leipzig*, 1853.

12. Palæontographica : Beiträge zur Naturgeschichte der Vorwelt. Von Dr. DUNKER u. HERM. VON MEYER. 4to. *Cassel*, 1852. Vol. 1 is now complete. Of vol. 2, Nos. 1–6 have been published and No. 1 to 3 of vol. 3. (Compare Journal, September, '53, p. 280, No. 47.)

13. Traité de paléontologie ou Histoire Naturelle des animaux fossiles considérés dans leurs rapports zoologiques et géologiques ; par F. T. PICTET. 2d edition, vol 1st. 8vo, atlas 4to. *Paris*, 1853.

14. Bericht über die Leistungen im Gebiete der Palæontologie mit besondererez Berücksichtigung der Geognosie während der Jahre, 1848 und 1849. Von Dr. C. G. GIEBEL. 8vo. *Berlin*, 1851.

15. Dimerocrinites oligoptilus. Ein Beitrag zur Kentniss der Gattung Dimerocrinites. Von R. PACHT. *St. Petersburg*, 1852. 8vo.

16. Description of the fossils of Syria ; by T. A. CONRAD. 4to, with plates. From official report of the U. S. Expedition to explore the Dead Sea and the River Jordan ; by Lieut. W. F. LYNCH, U. S. N. *Baltimore*, 1852.

17. Silicification organischer Körper. Eine geologische Abhandlung von ALEX. PETZHOLDT. *Halle*, 1853. 4to.

18. Fossile Flora des Uebergangsgebirges. Von Dr. H. R. GÖPPERT. *Bonn*, 1852. 4to, with 44 plates.

19. Iconographia plantarum fossilium. Von Dr. FRANZ UNGER. *Wien*, 1852. Fol., with 22 pl. (From the 4th vol. of the Trans. of the Imp. Acad. of Sc.)

20. Die Ammoniten von Swinitza. Von JOH. KUDERNATSCH. *Wien*, 1852. Fol., with 4 pl. (From the Trans. of the Imp. Geol. Inst.) Vol. 1.

21. Die Gasteropoden der Gosaugebirge in den Nordöstlichen Alpen. Von Dr. L. F. SEKELI. *Wien*, 1852. Fol., with 24 pl. (From the same.)

22. Palæobromelia, ein neues fossiles Pflanzengeschlecht. Von Dr. C. von Ettingshausen. *Wien*, 1852. Fol., with 2 pl. (Id.)

23. Beitrag zur Flora der Wealdenperiode. Von Dr. C. v. Ettingshausen. *Wien*, 1852. Fol., with 5 pl. (Id.)

24. Die fossilen Mollusken des Tertiärbeckens von Wien, unter der Mitwirkung von P. Partsch, bearbeitet von Dr. M. Hörnes. Nos. 1 to 4. *Wien*, 1851–52. Fol., with 20 plates.

25. The Ancient Fauna of Nebraska, or description of remains of extinct Mammalia and Chelonia, from the Mauvaises terres of Nebraska. By J. Leidy. *Washington*, 1853. 4to, with 24 pl. (From the Smithsonian Contrib. to Knowledge.)

26. Description of an extinct species of American Lion, Felis atrox.

27. A memoir on the extinct Dicotylinæ of America; by Jos. Leidy. *Philadelphia*, 1852. 4to, with 4 plates. (From the Transact. of the Amer. Phil. Soc., vol. 10.)

28. Allgemeine Palæontologie. Entwurf einer systematischen Darstellung der Fauna u. Flora der Vorwelt. Von C. G. Giebel. *Leipzig*, 1852. 8vo.

29. Untersuchungen an Schädeln des gemeinen Landbären als kritische Beleuchtung der Streitfrage über die Arten fossiler Höhlenbären. Von Dr. A. Th. v. Middendorff. *St. Petersburg*, 1851. 8vo.

30. Ueber die Reptilien u. Säugthiere der verscheidenen Zeiten der Erde. Von Herm. v. Meyer. *Frankfurt*, 1852. 8vo. L. A.

31. Sur le gisement et sur l'exploration de l'or en Australia; by M. Delesse. 28 pp. 8vo. Extr. des Ann. des Mines, 1853, iii, 185.

32. Sur les variations des Roches Granitiques; by M. A. Delesse. 18 pp. 8vo. Extr. du Bull. Soc. Geol. de France, [2] ix, 464. 1852.

33. Recherches sur les Roches Globuleuses; par M. Delesse. 62 pp. 4to, with 4 plates. Extr. Mem. Soc. Geol. de France, [2], t. iv.—We propose to give an abstract of this memoir in our next number.

34. Über der orographische und geologische structur der Gruppe des Monte Rosa. Von Herm. Schlagintweit. 20 pp. 4to, with 2 plates. *Leipzig*, 1853.—Aus "Neue Untersuchungen über die physicalische Geographie und die Geologie der Alpen," von Adolph Schlagintweit und Herm. Schlagintweit.

35. *On the Production of Gold in the British Islands;* by J. Calvert, (Proc. Brit. Assoc., 1853, fr. Athen., 1104.)—From his own exploration, from researches in various works, and from communications, Mr. Calvert stated that gold was found in forty counties in the British islands, and over an area of 50,000 square miles. He thus classified the gold regions:—The West of England, North Welsh, Mid-England, of Northumbrian, Lowland, Highland, Ulster, and Leinster. The West England region might be divided into three districts—Cornwall, Dartmoor and Exmouth, or West Somerset. In Cornwall, the tin-streams which were of the same composition as gold-diggings, had long been known to contain nuggets and coarse dust, or hops of gold, but had only been slightly worked by Sir Christopher Hawkins, at Ladoch. The largest Cornish nugget was not worth more that about ten guineas. The Cornish districts were very rich in gold. The Dartmoor district contained gold in its northern and southern streams. A miner, named

Wellington, got about 40*l.* worth of gold, at Sheepston, and Mr. Calvert had obtained gold from the granite by this process. In the West Somerset were four companies for working gold ores. From 55 tons of Poltimore ores, 102 ounces of gold were lately reduced, being at the rate of 16 dwts. per ton, or twice the rate of the St. John del Rey ores. The West Somerset district probably embraced gold sites at Combe Martin and the Mendips. The North Wales district might embrace all the western counties of the principality. There were no reported river deposits, but gold ores had been worked at Carnhusian, Isso, Berthllwyd, Dolfrwynos, and other places. The Northumbian regions embraced Alstone Moor ; but the chief gold-field was in Westmoreland and Cumberland. In the Goldscoop mine, gold had been found in the copper for ages, and he (Mr. Calvert) had discovered it in many of the ores and rivers of the district. He showed specimens from High Treby, Caldbeck Fells, the Buttermere and Crumwick-road, Borrowdale, Buttermere, Bassenthwaite, and a fine lump of gold gossan which weighed originally 57 oz. The South of Scotland district had only been worked for its river deposits in Clydesdale and Nithsdale, but in his (the lecturer's) opinion, it extended throughout the lowlands. Gold was found in about forty brooks or gullies, and all of the miners have gold for sale, obtained in their holiday excursions. Mr. Calvert mentioned that in the manuscripts of Queen Elizabeth's time, the diggers relied on keele, a reddish earth, as an indication of gold, and the miners do now. He had seen it also in Westmoreland, and had recognized it also in Australia and elsewhere. He found gold in the Lowther Burn, Long and Short Cleuch Burns, Mannock Water, Kepple Burd, Glengomar, Elvanwater, Goldscour, and other places. At Wanlockhead he saw gold in the midst of the town. At one place the miners, two years ago, got gold, which at Glasgow they sold for 42*l.* Gold was reported in Perthshire, Fifeshire, Stirlingshire, and Linlithgowshire. The Highland gold regions were unexamined. Gold localities had been reported in Aberdeenshire and Sutherlandshire. The Wicklow diggings were only shortly referred to. It appeared, by returns obtained from the Dublin goldsmiths, that the present supply of the peasantry was about 2,000*l.* a year. In Ulster the peasantry worked the aura or gold mountains in Antrimshire, and the Mayola streams in Londonderry yield gold. The yearly produce of gold in these islands was now about 5,000*l.* a year, which might be largely increased. The number of gold bearing streams known was one hundred. Gold had been found in nearly all the clay-slate districts. Many of these were worked in the Middle Ages, and probably also by the Romans. Gold, in ores, was found associated with silver, lead, copper, iron, and zinc ; with quartz, granite, slate, oxyd of iron, sulphate of iron. These ores have been worked of late only in Devonshire and Merionethshire. The river deposits were rudely worked by the miners or peasantry in Wicklow, Lanarkshire, Antrimshire, and Devonshire. The washing of gold-stuff in our home districts was very rude, and not equal to that in Australia, nor had there been for a long time any deep workings. Many rich gold ores were thrown away, and much metal was produced from which the gold was not refined. The only two gold-fields which had yet been worked had yielded considerable amounts. The Lanarkshire district from a quarter of a million to half a million,

the Wicklow above 100,000*l*. The largest known nuggets were 3lb. from Lanarkshire, and others of 2½ lb. from there and Wicklow. The importance of attending to this branch of the national resources was strongly urged. Mr. Calvert concluded by stating that he considered the clay-slate formations of Canada would soon be discovered to be a vast gold-field.

36. *Reports of Professor Henry D. Rogers, on Wheatley Brookdale and Charleston Mines, Phenixville, Chester Co., Pennsylvania.* 40 pp. 8vo.—The lead-veins of Phenixville are very singularly productive in fine crystallizations of the ores of lead, and according to the report of Prof. Rogers, they appear to promise well in an economical point of view. The specimens of the sulphate, carbonate, molybdate, and phosphate of lead are of remarkable beauty.

The veins have a general parallelism, ranging with few exceptions, about N. 32°–35° E. by compass. They intersect a gneiss rock, and some of them also cut through an overlying red shale which Prof. Rogers states is probably of the triassic age, or perhaps of the older oolitic.

They are therefore subsequent in origin to the shale. Numerous trap dykes also intersect the same red shale formation in this region as well as in the Connecticut valley. The lodes confined to the gneiss in general bear lead as their principal metal, and those which intersect also the shale contain ores of copper. Zinc ores (blende and calamine) prevail in both sets of veins, but somewhat more abundantly in the latter. The gneiss has a dip of 30 to 40 degrees, generally in the direction S. 20° E.; but there are many variations in the amount of dip near veins.

III. Botany.

1. *Harvey: Nereis Boreali-Americana; or Contributions to a History of the Marine Algæ of North America.* Part II. *Rhodospermeæ.* March, 1853. pp. 258, 4to. Plates 13–30; colored. Separate issue, from the fifth volume of the *Smithsonian Contributions to Knowledge.*—Our extended notice of the first part, published a year ago, sufficiently explains the nature and scope of this elaborate work. The present part contains a full systematic account of our North American *Rhodospermeæ*, the rose-colored Algæ, which are much more numerous than the *Melanospermeæ*, or olive-green Algæ, as well as more difficult to discriminate. Over a hundred pages more of letter-press and twice as many plates are therefore devoted to their elucidation;—a liberal allowance, under the circumstances; but twice as many figures might have been given to advantage, were it not for the heavy expense of such beautiful colored plates. The roseate hues and delicate texture of the *Rhodospermeæ* render them charming objects for such pictorial illustration; and Dr. Harvey's pencil is unrivalled in this department. But it is next to impossible to find colors so bright and clear as those of nature. The *Rhodospermeæ* are remarkable for having, in all their species, two kinds of fructification, or rather two kinds of spores, borne always on different individuals, and each equally capable of germinating and reproducing the species. The *idea* of each species, therefore, includes two individuals, not however as in certain

of the higher plants, and in most animals, where the pair is of two sexes, the sterile fertilizing the fertile one; but here there are two sorts of fertile individuals, which mature each their particular kind of seed, or spore, independently. These Algæ, moreover, like the Fuci, produce *antheridia*, which discharge myriads of granules, analogous to the pollen of Phenogamous plants, although they have not been observed to execute the spontaneous movements which they do in the *Melanospermeæ*. It has been commonly assumed that only one of these two kinds of reproductive bodies could be regarded as true spores, the other being supposed to be of the nature of a *gemmule* or bud, analogous to the bulblets of the Lilium bulbiferum, for instance, only of the utmost simplicity of structure. But authorities are by no means agreed as to which is the real spore, and which the gemmule. Our author (in his *Manual of the British Marine Algæ*) had very plausibly maintained that the smaller bodies, contained in a conceptacle, were the true spores, and that the *tetraspores* were gemmules. The same view has been proposed by Mr. Thwaites; while, if we mistake not, the contrary is supported by the younger Agardh. The question can only be settled by ascertaining which sort of fructification is fertilized by the antheridia. To us, it seems antecedently most probable, that these Algæ are truly dimorphous in fructification, and that both kinds are veritable spores, equally fertilized by the antheridia.

It may here be remarked, that some direct evidence of fertilization by the antheridia has lately been furnished, in the *Fucaceæ*, by M. Thuret, whose observations were communicated to the French Academy of Sciences last spring. The spores of certain common dioecious species, received in a vessel of sea water, apart from any admixture of the contents of the antheridia, uniformly failed to germinate. While those similarly circumstanced, to which the contents of the antheridia were added, promptly germinated. Impregnation is therefore inferred to take place in this family, in much the same manner as in the *Rhizocarpeæ*, (see vol. xv, of this Journal, p. 31, et seq.) that is, the matured spore receives the fertilizing influence after its separation from the parent.

The classification of the *Rhodospermeæ*, is more recondite than that of the *Melanospermeæ*; and most of the essential characters can only be made out by careful dissections, under the microscope. Dr. Harvey adopts, with some criticism on minor points, the recent elaboration of Prof. Agardh. We have, it appears, on the shores of North America, 385 species, disposed in 78 genera, under 13 "orders." The handsomest of all our species, namely that formerly known under the name of *Delesseria Americana*, here assumes the rank of a new genus, which Dr. Harvey has appropriately called *Grinnellia*, "in honor of Henry Grinnell, Esq., of New York, whose whole conduct in promoting the search after the missing Arctic Expedition of Sir John Franklin, justly entitles him to the respect and gratitude of every man of science."

Before the third and concluding part of this unrivalled work is put to press, the accomplished and indefatigable author may have the opportunity of personally gathering important materials for it, on the western coast of our continent; since he may return in that direction from the expedition he has undertaken to the Australian shores, via Ceylon and

Singapore, thus circumnavigating the globe in his search for the objects of his favorite study.

The volume of *Smithsonian Contributions to Knowledge* (vol. v), of which the above forms a part, is filled with natural, historical, and physiological memoirs. The following relate to botany. A. G.

2. *Plantæ Fremontianæ; or Descriptions of Plants collected by Col. J. C. Fremont, in California;* by JOHN TORREY, F.L.S.—The subjects, ten in number, are each illustrated by a plate. The first subject is *Spraguea*, (*S. umbellata*,) a remarkable new genus of Portulacaceæ, dedicated to our well known and unrivalled botanical artist, Isaac Sprague, who made the excellent figures which illustrate the present memoir, and whose profound knowledge of botanical structure, as well as the services he has already rendered to our science, justly merits this compliment. The second is the new genus *Fremontia* (*F. Californica*,) which replaces the genus formerly dedicated to Col. Fremont, (the earlier published *Sarcobatus* of Nees.) The present is a most interesting as well as showy shrub, being a Bombaceous plant, allied to *Cheirostemon*, the famous *Hand-flower* of Mexico, itself anomalous in the order, like the present genus, from the imbricated calyx and the want of a corolla. Its characters scarcely throw any additional light upon the affinities of *Cheirostemon*, which, as the older and best-known genus, should have given its name to the division of the order which Dr. Torrey proposes for these two genera. *Fremontia* is perhaps the most remarkable addition which has been made to the flora of the United States within recent times; unless the palm be yielded to the new Sarraceniaceous plant, presently to be mentioned. The third article illustrates *Librocedrus decurrens*, a new Californian Arbor-vitæ; a genus otherwise confined to South America and New Zealand, and perhaps to be reunited to *Thuya*. The fourth subject is the new genus *Coleogyne* (*C. ramosissima*,) of uncertain affinity, apparently most approachtng *Chrysobalanaceæ or Rosaceæ*, (the author inclines to the latter,) notwithstanding the opposite leaves. The character which gives the name is a curious tubular sheath, belonging either to the disk or the andrœcium, which encloses the pistil. The fifth, *Emplectocladus fasciculatus*, is a new Rosaceous genus, probably of the tribe *Dryadeæ*; but the fruit is unknown. The sixth, *Chamæbatia foliolosa*, is a Dryadeous genus, indicated about the same time both by Dr. Torrey, and Mr. Bentham, and published by the latter in his *Plantæ Hartwegianæ*, but now admirably illustrated by the former. These articles include some valuable criticisms on the arrangement of *Dryadeæ*. Seventhly, in *Carpenteria Californica*, we have a new genus allied to *Philadelphus*, but 5–7-merous, and with an almost free calyx. Whatever evidence it furnishes in respect to the affinity of *Philadelphus* goes to show that that genus belongs to the order *Saxifragaceæ*, with which the "collateral relationship," as Dr. Lindley terms it, is so strong, that no difference whatever remains, except the convolute æstivation of the petals; which is of little moment while they are imbricated in *Fendlera*, and valvate with a slight modification in *Deutzia*. The eighth subject is *Hymenoclea*, Torr. and Gray, a curious genus of *Compositæ* allied to *Franseria*, of which last also two new species are described. The ninth is *Amphipappus Fremontii*, a Composita between *Gutierrezia* and *Solidago*, the brief characters of

which, as well as of *Hymenoclea*, had already been published. The tenth is *Sarcodes sanguinea*, a singular new genus of *Monotropeæ*, intermediate between *Hypopithys* and *Schweinitzia:* in this connexion are given some important remarks on this group of plants and the *Pyroleæ*, from which the author entirely excludes *Galax*. It should be remarked these genera date as far back as the year 1850, when the plates were engraved, and an abstract of their characters was read before the American Association for the advancement of Science, at the New Haven Meeting, and published in its proceedings.* A. G.

3. *On Darlingtonia Californica, a New Pitcher-plant from Northern California;* by JOHN TORREY, F.L.S. (With a plate.)—The foliage and scape of this plant, without flowers or fruit, was discovered by Mr. Wm. D. Brackenridge,† assistant botanist of the U.S. Exploring Expedition under Captain Wilkes, on the route from Oregon to San Francisco. The curious fish-tailed appendage to the hood of the pitchers, and the bracteate scape suggested the idea that the plant might be a new Sarraceniaceous genus, rather than a true Sarracenia. This proved to be the case, when flowering specimens were obtained from the same locality (near Shasta Peak) by Dr. G. W. Hulse; as these have several-flowered scapes, no calyculus, a very reduced proper lamina to the petals, almost definite stamens in a single row, a turbinate ovary with a depressed and dilated top, and, above all, a naked (five-cleft) style, without the umbrella so characteristic of *Sarracenia*. From *Heliamphora* (of Guiana,) it differs quite as widely; in fact it is a perfectly distinct third genus of this remarkable type, intermediate between the two before known. The only character it affords likely to throw additional light upon the affinities of the group, hitherto so obscure, is that of the almost definite stamens, which so far as it goes, favors Dr. Planchon's view, that it is related to *Pyrolaceæ*. We are well pleased that this most interesting and striking accession to the flora of our country, is to commemorate one of the oldest and best of our botanists, Dr. Darlington.‡ During the autumn and winter, living roots of this plant, packed in dry peat-moss, might be transported to the Atlantic coast, with good hope of success. Let our Californian readers take notice, that a small box of such roots, delivered alive in Boston, New York, or London, would be pecuniarily as valuable as a considerable lump of gold, and would furnish a handsome and highly curious acquisition to our gardens. A. G.

* We find that this and the two following memoirs are not included in the fifth volume of the *Smithsonian Contributions:* but a separate issue of them was published early last summer.

† Not J. D. Brackenridge, as the name is recorded, both in the Narrative of the U. S. Exploring Expedition, and in the present memoir.

‡ Our accomplished and venerable friend will doubtless be amused, and perhaps as much surprised as we were, to find that a German reviewer of the third edition of his *Flora Cestrica*, in the *Bonplandia* (a Botanical Journal published at Gottingen, and edited by B. Seemann), severely criticises his *English* style, pronouncing it to be so redundant in Americanisms, that he would advise Herr Darlington, should his work reach a fourth edition, to engage the assistance of some person better acquainted than himself with the idioms of the English language! We profess a somewhat critical acquaintance with our mother tongue, and must say that we had not noticed the Americanisms in question; nor had we ever expected to see Dr. Darlington taking lessons in the English language from a *Dutchman*.

4. *Observations on the Batis maritima of Linnæus;* by JOHN TORREY, F.L.S. (With a plate.)—This is a thorough history and illustration of this obscure plant, the plate filled with beautiful and clear analyses, from the pencil of Mr. Sprague; a fact not recorded upon the plate, as it should have been. A second species, *Batis Californica*, is indicated, which was discovered by Dr. C. C. Parry, near San Diego. As to the affinities of the genus, Dr. Torrey inclines to adopt the views of Dr. Lindley, (who refers it to his Euphorbial alliance,) but regards it as the type of a proper natural order. A. G.

5. *Plantæ Wrightianæ Texano-Neo-Mexicanæ;* PART II. *An account of a Collection of Plants made by Charles Wright, A.M., in Western Texas, New Mexico, and Sonora*, in 1851 and 1852; by ASA GRAY, M.D., pp. 119, with four plates. The greater part of this important collection was made under the auspices of Col. J. D. Graham, then in charge of the U. S. and Mexican Boundary Survey; the remainder, under his successor, Major Emory. The account of the collection is carried in the present memoir only to the end of Compositæ. A. G.

6. *A Flora and Fauna within Living Animals;* by JOSEPH LEIDY, M.D., (pp. 67, with 10 plates.)—Dr. Burnett has already called attention, in the last number of the Journal, to this elaborate memoir. From a botanical point of view, it may be pronounced to be a contribution of the highest order and interest; and the plates are unsurpassed, if not unequalled, by anything before published in this country. A. G.

7. *Exotic Fungi from the Schweinitzian Herbarium, principally from Surinam;* revised by the Rev. M. J. BERKELEY, M.A., F.L.S., and Rev. M. A. CURTIS, D.D. (From the Journal of Academy of Natural Sciences, N. Ser. vol. II.—A large number of species of fungi are here described, and three new genera are characterized, namely, *Coilomyces*, *Dasypora*, and *Corallomyces*. A plate is devoted to the illustration of these, and of certain species of several other genera. A similar memoir on the Schweinitzian Fungi of the United States is promised: it must prove a very important contribution to our mycology, which already owes so much to the individual and conjoined labors of Messrs. Berkeley and Curtis. A. G.

8. *Botanical Necrology.*—There have been several recent deaths among the botanists of Europe. The most important loss sustained is that of Professor ADRIEN DE JUSSIEU, the son and successor of A. L. de Jussieu (author of the *Genera Plantarum*), and the grand-nephew of Bernard de Jussieu, the correspondent of Linnæus, and the first to sketch the Natural System of Botany. M. de Jussieu, was himself one of the soundest and most learned botanists of the age, and a most estimable man, greatly beloved and admired by all who knew him. His decease will be greatly felt in Paris; both in the Academy of Sciences, of which he was this year the president, and at the Jardin des Plantes, with which he has been long connected. He died on the 29th of June, at the age of 56 years. He had long been in delicate health, and for the last four years had suffered grievously from an affection of the stomach, which proves to have been cancerous. Leaving no male heirs, with him closes the illustrious line of the Jussieus, which has been dominant in botany for more than a century. The botanical chair occupied by Jussieu at the Museum of the Garden of Plants, has now been

suppressed, and a chair of Paleontology established in its room, of which M. d'Orbigny is the incumbent.

About a year ago, another distinguished name in botany became extinct, by the death of M. ACHILLE RICHARD, Professor of Botany, &c., at the *École de Medécine*, and son of L. Claude Richard, one of the most distinguished contemporaries of A. L. de Jussieu. M. Richard was celebrated as a professor, and held no mean rank as a botanist. His chair in the Institute was filled by the election of Dr. C. Montagne, the well-known Cryptogamist; that in the Ecole de Medécine by M. Moquin-Tandon, formerly of Toulouse.

We hear of the decease of Dr. PRESL, of Prague, the author of the *Reliquiæ Hænkeanæ*, *Tentamen Pteridographiæ*, &c., &c. Also of the recent death of Dr. WALPERS, of Berlin, author of the *Repertorium*, and the *Annales Botanices Systematicæ*; a useful record of all plants recently published. He is said to have died by his own hands, after notifying his botanical friends that he was dissatisfied with the world, which would not recognize his merits. It is reported that Dr. Petermann, of Leipsic, will continue the *Annales*,—a work much needed,—or carry on a similar publication.

A. G.

IV. ZOOLOGY.

1. Memorias sobre la Historia Natural de la Isla de Cuba; par FELIPE POEY. *Habana*, 1853. Vol. 1, No. 4.

2. Histoire des sciences naturelles au moyen age, ou Albert le Grand et son époque, considérés comme point de départ de l'école expérimentale; par F. A. POUCHET. *Paris*, 1853. 1 vol. 8vo.

3. A Naturalist's rambles on the Devonshire Coast; by PHILIP HENRY GOSSE. *London*, 1853. 1 vol. 8vo.

4. A synopsis of the Mollusca of Great Britain arranged according to their natural affinities and anatomical structure; by W. I. LEACH. *London*, 1852. 2 vols. 8vo.

5. Mélanges biologiques tirés du Bulletin physico-mathématique de l'Académie impériale des sciences de St. Petersbourg. Vol. 1, No. 6. 8vo. *St. Petersbourg*, 1853.

6. Der Harnstoff als Maass des Stoffwechsels. Von TH. L. W. BISCHOFF. *Giessen*, 1853. 8vo.

7. Uber die Larven u. die Metamorphose der Echinodermen. 4th paper. By JOH. MULLER. *Berlin*, 1852. 4to.

8. Ueber Synapta digitata ü. ueber die Erzeugung von Schnecken in Holothurien. Von JOH. MÜLLER. *Berlin*, 1852, folio with 10 plates.

9. Zur Naturgeschichte der Adria. Von L. K. SCHMARDA. *Wien*, 1852. fol. with 7 pl. (From the 4th vol. of the Trans. of the Imper. Acad. of Sci.)

10. Das Thierleben der Alpenwelt. Naturansichten u. Thierzeichnungen aus dem schweizerischen Gebierge. Von Fr. v. TSCHUDI. *Leipzig*, 1853. 8vo.

11. Indicis generum Malacozoorum supplementa et corrigenda. Auctore A. N. HERRMANSEN. *Cassellis*, 1852. 8vo.

12. Histoire naturelle des végétaux parasites qui croissent sur l'homme et sur les animaux vivants; par CH. ROBIN. *Paris*, 1853. 8vo, with atlas.

13. L'organisation du régne animal; par EMILE BLANCHARD. 5th No., folio. *Paris*, 1852. December.

14. Odontographie. Vergleichende Darstellung des Zahnsystems der lebenden u. fossilen Wirbelthiere. Von C. G. GIEBEL. 2d No. 4to. *Leipzig*, 1853.

We intend to give a detailed account of some of these works in the next number of the Journal. L. A.

III. *Lectures on Surgical Pathology, delivered at the Royal College of Surgeons of England*; by JAMES PAGET, F.R.S., &c. 2 vols. 8vo. London, 1853. Vol. I, pp. 499. (Hypertrophy: Atrophy: Repair: Inflammation: Mortification: Specific Diseases.) Vol. II, pp. 637. (Tumors.)

The Art of medicine is as old as humanity itself, but Pathology elevated to the dignity of a science which can be studied in an intelligent and definite way, is of quite recent origin.

Physiology and Pathology must always be mutual aids, for the latter is but a fallen condition of the former; and no one can clearly understand the physical conditions of disease, until he has learned the normal structural, and functional peculiarities of the parts in which it occurs.

The advance which Hunter gave to Pathology may be traced to this cause; his great store of physiological knowledge, derived too from direct study, enabled him, in the investigation of morbid conditions, to make that peculiar colligation of facts which has its expression in a *law*. The great hindrance of truth in the study of disease has been, that men have started upon the foregone conclusion that disease must be a foreign enemy, *sui generis*, which invades the healthy body; while they should have regarded it almost always, as merely a peculiar conditional form of the ordinary action of healthy parts, a leading feature of which is, that such action is *below* that of the normal standard. Perversion of the normal nutrition marks the more outstanding conditions of disease, and the leading tendency of modern research is to revive not a few of the ancient doctrines of humoral pathology, although based upon far more scientific data.

Mr. Paget's lectures were delivered some years since, and at that time were successively published in the London Medical Gazette. As they were then extensively read, their appearance in the present collected form, is not an event as important as though the work had not before been seen. It should be remarked, however, that the last of them were delivered last year (1852), and the whole have been put up in the present form with full reference and knowledge of advancing science. We wish particularly to call the attention of our readers to this work, not from its *practical* value in surgery, but because, in seeking to illustrate his subject, the author has taken up in a very philosophical manner, many of the fundamental physiological conditions of Life;—and in so doing has shown that he by no means ignores the relations of development and growth in the humbler forms of life, where many of these conditions have their clearest exemplification. Nutrition, its nature, purpose, and conditions, healthy nutrition, the formative process, growth, hypertrophy, atrophy, degeneration, reproduction of injured and lost parts, these are some of our author's preliminary studies, which are treated in a plain yet lucid manner, leaving no doubts in the mind of

the reader. These topics are taken up preparatory to a consideration of the more special process of the healing art involved in practical surgery. These it is not our province to discuss or even touch upon; but what we desire to impress is the necessity of studying the conditions of nutrition in all its phases of growth and repair, as illustrated in the lower forms of life where nature has laid bare the processes for our observation.

The study of the development, growth and repair of polypes, medusæ, and spiders, may seem to have the remotest connection with the domain of the pathologist, but the unity of plan by which nature proceeds in her processes, whether it be to develope a future or to recover a past perfection in the types of structure, makes the study of her humbler forms imperative with him who would have a wide comprehension of her laws. Were we so minded, this train of thought might be very pleasantly extended, and we could cite, beside our author, examples of men distinguished in their art, whose eminence is not a little due to that broad grasp of organic phenomena derived from scientific studies of this kind.

But we will quote one passage where Mr. Paget expresses himself on this very point, and with his usual felicity. It is near the conclusion of the seventh Lecture :—

"I may seem in this, as in some earlier lectures, to have been discussing doctrines that can hardly be applicable to our daily practice, and with illustrations drawn from objects in which surgeons may have but little interest. Let me, then, if only in apology, refer to some of the considerations which are suggested by studies such as these. Let me first, then, express my belief that, if we are ever to escape from the obscurities and uncertainties of our art, it must be through the study of those highest laws of our science, which are expressed in the simplest terms in the lives of the lowest orders of creation. It was in the search after the mysteries—that is, after the unknown highest laws—of generation, that the first glance was gained of the largest truth in physiology; the truth of the development of ova through partition and multiplication of the embryo-cells. So may the study of the repair of injuries sustained by the lowest polypes, lead us to the clearer knowledge of that law, in reliance of which alone, we dare not to practice our profession; the law, that lost perfection may be recovered by the operation of the powers by which it was once achieved. * * * * Then, let us not overlook those admirable provisions, which we may find in the lives of all that breathe, against injuries that, but for these provisions, would too often bring them to their end before their appointed time, or leave them mutilated to perish a painful and imperfect life. We are not likely to undervalue, or lose sight of the design of all such provisions for our own welfare. But we may better appreciate these, if we regard them as only of the same kind as those more abundantly supplied to creatures whom we are apt to think insignificant: indeed, so abundantly, that, if with a consciousness of the facility of self-repair, self-mutilation is commonly resorted to for the preservation of life."—**Vol. I, p. 165, 166.**

Pleasant as it would be to discuss these points and relations further, and to follow them in their close consequential detail to those methods of art which belong to the relief of humanity and the restoration of our

broken physical nature, yet this would hardly belong to our department. We shall be pleased if we succeed in calling particular attention to a work written in a fine philosophical spirit, with a true English practicality, and in a style excellent for its plainness and lucidity.

We may add that the "getting up" of these volumes is quite complete. Printed in a large clear type, and on excellent paper, it is indeed, a delight merely to read such writings. There are, moreover, constant wood-cuts intercalated in the text, which, for cleanness, are in keeping with the rest of the "work" of these volumes; and, finally, what we always like to see, there is a very complete and convenient index at the end.

W. I. B.

V. Astronomy.

1. *New Comet*, IV of 1853, (Astr. Journal, 64.)—On the night of Sept. 11, 1853, Mr. C. Bruhns, in Berlin, detected near the forward paw of the *Great Bear*, a "large faint nebulous comet, resembling a star-cluster." Its position Sept. 11, $13^h\ 12^m\ 15^s{\cdot}3$ was R. A. $126°\ 59'\ 11''{\cdot}5$, and Decl. $+\ 44°\ 51'\ 33''{\cdot}6$. Its position Sept. 15, $12^h\ 13^m\ 53^s{\cdot}8$ was $132°\ 22'\ 8''{\cdot}9$ in R. A., and $+\ 42°\ 29'\ 51''{\cdot}5$ in Decl. Up to Sept. 17, no indications of a tail were visible, and the nucleus continued to present the appearance of an unresolved nebula, with numerous points of light. From the observations of Sept. 11, 13, 15, Mr. Bruhns had deduced the elements given below, which however, owing to the disadvantageous position of the comet, he considers as being only a tolerable approximation.

T. Oct. $16^d.6122$.

Long. of perihelion,	- - -	301° 23′	20″·4
" asc. node,	- - -	222 13	44 ·1
Inclination,	- - - -	63 6	5 ·1
Log. perihelion dist.,	- - -	9·200658	

Motion retrograde.

2. *Proserpine*, (26) (Astr. Journ. No. 63.)—The following elements of this planet were computed by Mr. A. Krüger:—

Epoch, 1853, June 10·0.

Mean anomaly,	- -	358° 15′	12″·1
Long. of perihelion,	-	227 34	4 ·6 } Mean Eqnx.
" asc. node,	- -	45 55	34 ·3 } 1853, Jan. 0·0
Inclination,	- - -	3 36	14 ·0
Angle of excentricity,	-	4 20	30 ·3
Log. semi-axis maj.,	-	0·418836	
" mean daily motion,		2·921752	

3. *Second Comet of* 1853, (Astron. Nach., 859.)—The elements given below, were computed by Mr. C. Bruhns, from observations of April 14, 16, and 19.

T. = 1853, May 10·39998 M. T. Berlin.

Long. of perihelion,	- -	201° 12′	57″·2 } Mean Eqnx.
" asc. node,	- -	41 12	52 ·3 } 1853·0
Inclination,	- - -	57 53	3 ·0
Log. perihelion dist.,	- -	9·956398	

Motion retrograde.

4. *Third Comet of* 1853, (Athenæum, Sept. 17.)—The comet which was so conspicuous near the western horizon about the first of September, reached its greatest brilliancy on the 3d of Sept.; on which day, shortly before one o'clock, P. M., the nucleus was perceived in full daylight by Mr. HARTNUP, of the Liverpool Observatory. It appeared round, and about 9″ in diameter, without any appearance of a tail.

5. *Shooting Stars of August* 9–10*h*, 1853.—In addition to the observations reported in the last number of this Journal, the following have been received. Mr. *Coulvier Gravier*, at Paris, reports (Comptes Rendus, tom. 37, p. 288) the hourly number on the 9th at 49, and on the 10th, 56, but omits to give the number of observers, and the time of night in which his observations were made.

Rev. Andrew T. Pratt, M.D., Missionary of the American Board, at Aintab, Turkey, has communicated some observations made by himself and another person Aug. 9–11th. The evenings were favorable, but their view was confined to the part of the heavens west of the meridian, and above the altitude of twenty degrees.

On the 9–10th, from 9 to 10 o'clock, they saw 36, and from 1 to 2 o'clock, 66. On the 10–11th, from 12 to 1 o'clock they saw 78, and from 1 to 2 o'clock, 88. The general direction of the meteors was quite uniform, the radiant being near *Cassiopeia*.

These observations agree with those heretofore made at New Haven as to numbers, general direction and greater frequency after midnight, and confirm, what may perhaps be considered as sufficiently well established, the cosmical origin of shooting stars.

VI. MISCELLANEOUS INTELLIGENCE.

1. *Note to Prof. Barnard's paper on Expenditure of Heat in the Hot-air Engine, page* 351; by the AUTHOR.—In Appleton's Mechanic's Magazine for September, it is editorially stated, on the authority of Capt. Ericsson, that the engines now in preparation for the caloric ship are to have working cylinders of 6 feet diameter and 8 feet stroke, are to be double-acting, and are to draw their supplies from a reservoir of highly condensed air kept artificially cold, to which the escaping air is to be returned. This construction requires no modification of the theory of the engine, but renders necessary, in the general formula, the substitution of the number expressing the pressure in the air-chamber, in place of 15, the pressure of the atmosphere. It is proposed to work against a pressure of six atmospheres—say 90 lbs. The mean positive working pressure will then be to that of the abandoned engines, as $90\times6^2 : 15\times14^2$, or as 54 : 49. The stroke, being also increased in the ratio 4 : 3, will increase the nominal horse-power, should the same number of revolutions be maintained, in the same ratio. The powers given in this table, therefore, being multiplied by $\frac{54\times4}{49\times3}=\frac{72}{49}$ will give the corresponding powers of the new engines.

The question of economy, however, remains unaffected, since the mass of air to be heated is increased in precisely the same ratio as the power. The mass varies as the product of volume into density;

that is, as $6^2\times8\times90 : 14^2\times6\times15$, or as $72 : 49$, the same ratio as the preceding. The success of the engine in this form will depend entirely upon the heating apparatus. Should that be no more efficient than the former, the failure will be more signal, because of the increased demand made upon it. It is to be presumed, however, that the inventor's attention is now directed mainly to this point, and that his attempts at improvement may not be entirely fruitless.

The formula for mean pressure (page 248 of this volume) may be made entirely general, by substituting a letter, as Π, to stand for the pressure against which the engine works. It may also be rendered more simple in appearance by making the following substitutions. Put $k^{\frac{1}{\gamma}}=\mu$, and $\varkappa\frac{\gamma-1}{\gamma}$. With these changes, it takes the following form, which is here given in full, in consequence of the typographical error in the former article.

$$P=\Pi a\left[k^{\varkappa}m(\mu-l^{-\varkappa}m^{\varkappa})+\frac{km}{1-\gamma}(l^{\gamma-1}-1)-\frac{l^{-\varkappa}m}{1-\gamma}(l^{\varkappa}-k^{\varkappa}m^{\varkappa})+m-1\right]$$

In Appleton's Mechanics' Magazine for July is contained a very able and satisfactory examination of the general theory of the caloric engine by Maj. J. G. Barnard, of the U. S. Engineers. As the article in this Journal for September appeared considerably later, in the order of time, it might naturally have been expected to contain some comparison of results with those of Maj. Barnard. This would have been the case but for the necessity of sending to the press before it was possible to see his article.* The difference in numerical results between Maj. Barnard and the present writer, are owing mainly to the difference of assumed maximum temperature in the working cylinder; this being in the one case put at 380° F. (the temperature observed on the trial trip of the "Ericsson,") and in the other, at 150° F. above melting ice, which has always been claimed by Capt. Ericsson to be a temperature attainable without difficulty. From what has already been said above, it will be seen that, at present, the writer is disposed to believe that Maj. Barnard has assumed the highest temperature attainable with the mode of heating heretofore employed. Whether the improvements which Capt. Ericsson has now in hand will remove this difficulty remains to be seen.

2. *The Conical Condenser, a Telescopic Appendage;* by Lieut. E. B. Hunt, Corps of Engineers, U. S. A., (Read before the Am. Assoc. for the Advancement of Science at Cleaveland, Aug., 1853.)—I would respectfully submit to the consideration of this Section, an arrangement which seems to make possible an almost indefinite increase in the space-penetrating power of telescopes. At the same time, I hardly anticipate that this arrangement will be of practical convenience; but whether it prove useful or not, it possesses a mathematical or optical beauty, which makes it worthy of presentation here.

* A similar reason must prevent, in the present number, any allusion to the continuation of Maj. Barnard's investigation, which, it is understood, is to appear in October.

It consists essentially of two conical mirrors of the same angle, and with a common axis, so placed that the beam of light is first incident on the inner surface of the exterior cone or ring-shaped section of a cone, and is thence reflected on to the exterior surface of the second cone, whence it is again reflected, in certain cases, parallel to its first direction. Thus the first or ring-shaped beam of rays is condensed, so that it can be received on the object-glass of a telescope, in condition for accurate convergence, the quantity of rays being greater as the ring-radius is increased.

To appreciate this, we first observe that if a ray be continually reflected between two parallel mirrors, its directions, after all the even reflections, are parallel to each other. Let the two cones now be assumed, with a common axis and equal vertex angles, the inner surface of the outer cone, and the outer surface of the inner cone, being reflectors.

First, take a beam of rays parallel to the common axis. Each ray of this beam which falls on the outer cone, and again, after reflection, on the inner cone, will emerge parallel to its primary direction, as the normals at its two points of reflection are parallel. Thus all the rays from the outer ring, however great its radius be, will in this case be condensed into a new beam parallel to the first, but emerging from the inner cone. An object-glass, or rather a telescope, with its axis coinciding with the cone axis, will thus receive a condensed beam, whose intensity exceeds that of the simple beam, in the same ratio that the orthographic projection of the effective ring by the incident-beam exceeds the area of telescope aperture. The condensing cones are thus optically a perfect arrangement for increasing the intensity of light from a star on the axis. Cutting off from the inner cone just enough to cover the object-glass, and from the outer one the part supplying rays to that portion thus determined, and mounting the two as a telescopic appendage, light may be condensed to any extent, from an axis-star, by increasing the ring-radius. The effect would be identical with that of enlarging the object-glass to an area equal to the orthographic ray projection of the ring. This ring could doubtless be increased to twenty or thirty feet diameter, which, with a two feet aperture would give such an illumination from an axis-star as is overpowering in contemplation.

Now, let a beam be taken, making, with the instrumental axes, a small angle, such as that of all beams in an astronomical field must always be. To trace this through the condenser, suppose the ring resolved into elementary rings, and the beam into corresponding elementary cylinder beams. Take the ray through the vertex of normals for an elementary ring, as an axis, and revolve all the rays of the elementary beam into the same plane. The rays fall parallel in revolution, and their points of reflection fall in an arc, subtending twice the angle between the axis of the beam and that of the cones. As the meridian planes in the elementary cylinder contain both the ray and the normal, all the reflected rays will cut the axis of revolution, and will be brought to accurate convergence on it, except for the spherical aberration due to the small arc above named. In the revolution we have effected, the points of second reflection will fall into a curve, dif-

fering not very much from a circle; by examining which, it will be seen, that it gives a counter or corrective aberration, which would make the final emergence nearly, in a beam, parallel to the first incident beam. Indeed, if we suppose an elementary beam to proceed, in inverse order, falling first on a ring element of the inner cone, it will have an emergent direction in all parts exactly parallel to that of the beam first reflected from the outer ring element. Thus the two reflections are strongly corrective of each other, and the incident elementary beam will emerge, after two reflections, nearly as a true beam, for all the extent of such a field as belongs to high telescopic powers. What is true of an elementary beam is equally true of the total beam.

It should be observed that the rays of each elementary beam lying in the plane through its axis and the axis of the cones emerge parallel to their first direction, and that for the adjacent portions of the ring, the lack of accurate emergence would be insensible. Thus, all points in the field have a perfectly correct defining part, in the condensing cones. Another important remark is that all incorrectly condensed rays are thrown *from* the centre of the field, thus leaving this part in its absolute perfection, and free from all possible confusion. The outer portion of the field is the least perfect, but even this has a correct definition, with less light, and some overlaying of wandering rays. To what extent around the axis the field would prove useful, experiment only can decide. As far as I can judge, this would be fully to the extent required in large telescopes, such as are now particularly desired for resolving the remote nebulæ, and in stellar observation in general. Much of the discussion of these mirrors, and their optical actions, I have omitted, as being superfluous here. My general conclusion is, that optically, this condenser is an available means of giving a vast increase to the space-penetrating power of telescopes.

The loss of light by each reflection should of course be taken into account, as a circumstance lessening the useful effect, in a degree, directly as the absorption, and depending on the material and polish of the reflectors.

Having presented the main optical properties of this arrangement, it remains to discuss its fitness for practical application.

Ordinarily, the most convenient plan would be to take cones whose elements make angles of 45° with the axis. This will bring the cone and ring, between the same limiting planes, perpendicular to the axis.

It would hardly be found practicable to append this condenser at the moving end of a large telescope with the present mounting. The size and weight would be found unwieldly, and would lead to frequent derangements of adjustment. If used at all, it must be, I imagine, by the introduction of a third plane reflector, so arranged opposite the inner cone as to deviate the emergent rays 90°, and to direct them through the telescope, horizontally fixed. This would enable us to mount a large ring on a firm circular frame, which revolves around one of its diameters, or rather around the fixed telescopic axis. The measuring arc of this revolution would give altitudes. This mounting would give only meridan observations. To observe at very limited distances from the meridian, a measureable rotation might be given to the plane mirror around its right line element, perpendicular to the telescopic axis. If

it be desired to observe through all azimuths and altitudes, the whole arrangement, including the telescope, can be made to revolve horizontally. Doubtless an equatorial mounting could be contrived, but I doubt if it could be made convenient.

The large ring would naturally be composed of segments, which could be cast in speculum metal, and polished by a revolving straight edge. These ring segments being developable, might be made of plate glass, cut into shape while plane, and bent, when heated, to the required curvature by a mould. Then a final polishing, and a pure silver backing, would complete them for mounting.

It is, perhaps, superfluous to dwell longer on this arrangement. I would say, in conclusion, that if an extension of telescopic power much beyond that now reached should be required, this arrangement presents a possible means of attaining it. At the same time, its complication, and its involving two or three reflections, will prevent its being so desirable as to overcome the difficulties incident to so novel a construction in this most difficult department of instrumental manufacture. As a means of condensing solar light or heat, I would ask particular attention to this apparatus. I see no reason why a heat of light focus may not be formed by the simple combination of these mirrors with a parabolic reflection, exceeding in intensity anything ever realized.

In using transit or other meridian instruments, it is now necessary for the whole telescope to turn in its axis, and for the observer to follow its rotation with much discomfort and torture of limb. There is a very simple mode of dispensing with all this, which occurred to Prof. Bache and myself, independently and nearly simultaneously. It has not yet been tried, and I know not when it will be.

Let the telescope be supported in any manner, with its axis horizontal and perpendicular to the meridian. Mount at its object-glass end a perfectly plane mirror, making an angle of 45° with the line of collimation, and arrange for this a rotation measured on a meridian limb. By this means, each point of the meridian will be passed in review, with no other motion than that of the mirror rotation. This mirror may be made a permanent appendage to the object-glass, or may be mounted quite by itself. The main difficulty would be in the first adjustment, and the setting up would then probably be easier than that of the existing transits.

A means of arranging this so as to get the internal reflection of glass, would be to compose the mirror surface of camera-lucida prisms, permanently fixed in échelon order. This, if perfectly executed, would be an excellent reflector, but it would be very costly. If silver mirrors can be formed which reflect 93 per cent. of the incident light at 45°, as Lord Rosse has found, they will be far the best solution of the problem. The electrotype art is surely so perfect in the Coast Survey Laboratory, that silver mirrors can be deposited on a speculum metal matrix, leaving only a final polish to be given. It is not rash to assume this, even though Lord Rosse failed in this very attempt.

Whether, on the whole, the introduction of this reflector, and the consequent revolutionizing of the transit, will prove desirable in practice, remains to be seen.

3. *Project of a Geographical Department of the Library of Congress.*—The following are the principal points in a plan for a geographical department of the Library of Congress, presented by Lieut. E. B. HUNT, U. S. Corps of Engineers, to the American Association for the Advancement of Science, at Cleveland, August, 1853.

I. That a Geographical department of the Congress Library be established, as a distinct and independently organized department, with its own executive officer,—the general direction being under the Joint Library Committee.

II. That special appropriations be made for this department, or that the Library Committee set apart a portion of the general Library appropriations for this purpose. During the period of collecting the great mass of existing materials, these appropriations would require to be proportionably large.

III. That the appropriated funds be applied to the collection, arrangement, and indexing of all important geographical materials relating to the whole world; also, in part to the necessary expenses of administration.

IV. Among the materials thus to be collected, the following classes may be mentioned: 1. A first-class terrestrial globe. 2. All materials illustrating the early and recent geography of the United States, both its sea-coast and interior, including traced copies of all valuable maps and charts in manuscript and not published. The materials for illustrating the past and present geography of each state, county, township and city, should be gathered by purchase, correspondence, and tracing. 3. All maps and charts on other parts of America. 4. The Admiralty or sea-coast chart of all the European and other foreign states, and the detailed topographical surveys of their interiors, where such have been made. 5. The most approved maps published from private resources, whether as atlases, nautical charts, or mural maps, including publications on physical geography, guide-books, railroad maps, and city hand-books. 6. A complete collection of all the narratives of voyages of discovery and exploration. 7. Geographical, geodetic and nautical manuals, and treatises, with all the requisite bibliographical aids to the amplest geographical investigation.

V. Having an organization and appropriations for gathering such a mass of material, it would be of the first importance to arrange complete and systematic indexes or catalogues which would at once make known all the material on each locality, and to have those materials so arranged as best to facilitate special research.

VI. A room for drawing, in which materials for the collection could be copied either for its files, or to answer public and private calls, would be indispensable for the completeness of this scheme. In this room, compilation could be conducted in answer to Congressional calls, and in keeping constantly corrected and filled out, a set of State maps on large scales, to which map publishers should have free access.

VII. A competent executive officer who would be able to maintain correspondence with persons having special geographical knowledge, and to keep a list of persons who could be addressed for additional information on foreign and domestic localities. Also, correspondence should be maintained with foreign geographical societies, and their publications should be secured with promptness.

VIII. The head of this department could present, through the Library Committee, an annual report, on the geographical explorations by our own and foreign Governments, or by individuals, so far as their results can be learned; making this, indeed, a synopsis of all the interesting and important geographical facts or publications for the year.

IX. Among the duties which would belong to this department would be that of calling attention to points demanding examination, or localities needing exploration. Also, it would be able to furnish the preliminary information for such explorations, or to indicate the sources whence it could be derived.

4. *On the Composition and Figuring of the Specula for Reflecting Telescopes*, (Proc. Brit. Assoc., 1853; Athen., 1098.)—Mr. Sollit commenced by stating that he had given his attention to this subject for years, and that he was more than ever convinced of its importance by the decided conclusion to which facts had led him, that reflectors, when once well and carefully made, were far less apt to deteriorate than refractors. In order to be intelligible to the section, it was necessary for him to go over some ground familiar to the public, since the researches of Lord Rosse, Mr. Lassell, and Mr. Nasmyth. He stated that he considered it to be a matter of prime importance that the copper and tin should be used in exact atomic proportions. He, following the numbers given by Berzelius, used the following proportions:—copper 32; tin 17·4. Lord Rosse's are, copper 32; tin 14·9. As the metal when thus composed was very hard, brittle, and difficult to work, he found that he could render it capable of reflecting white light equally well, if not better, and at the same time of taking a very uniform and beautiful polish, by introducing a little nickel in place of the tin,—and the following proportions he found on trial best:—copper 32; tin 15·5; nickel 2. He also found the introduction of a very small quantity of arsenic useful in preventing the oxydation of the tin when melting. Silver, as used by Mr. Lassell he also found excellent; but he was against the use of fluxes, as most injurious. The author passed over the casting and grinding with very slight notice; but dwelt on the composition and figuring of the polisher as of great importance. The composition as used by him was pitch and resin, and a small admixture of flour was found useful. The surface he grooved with concentric equidistant circular grooves,—and not in parallel and cross grooves, as used by Lord Rosse and Mr. Lassell. These concentric grooves he crossed by radial grooves, widening as they receded from the centre, so as to be bounded by curved outlines. By giving proper form and dimensions to these curves the parabolic form could be most accurately given to the spectrum in the process of polishing. The form of the curved outlines of these radial grooves he found should be parabolic. He concluded by stating the importance of not having the speculum too thin, and of using proper precautions in mounting and supporting it, to avoid any chance of the form being altered.

Dr. Scoresby regretted that having been in another section he had not heard the early part of the communication of Mr. Soilitt; but he rather thought Lord Rosse used concentric grooves in his polisher as well as parallel and cross grooves.—Prof. Stevelly confirmed the accuracy of this statement; and added that his memory was quite clear that Lord

Rosse considered it very important to use the copper and tin in atomic proportions, and said in his papers on it that uniformity of composition could not otherwise be hoped for. He also recognized the importance of using thick specula; the last which he had cast being not less than five inches thick. He also had used and recommended resin to be used to harden the pitch and flour for a purpose which by experience he had learnt to be important. Lord Rosse had also by the several motions and adjustments which he had contrived for the speculum and the polisher reduced the figuring of the speculum to an almost certain function of time: so that after the speculum had been a certain number of hours under the action of the polisher, he was well assured that the proper figure had been attained. Prof. Stevelly briefly described these motions and adjustments; and stated that the actual result was, an enormous circular disc of six-feet aperture, without crack or flaw, and of a splendid uniform polish, and reflecting light from objects of a perfectly natural tint.—Mr. Varley said he had found that the use of a little zinc in the composition of the speculum metal took from it the liability to tarnish which he had found so annoying. He expressed regret that Lord Rosse found it impossible to avoid microscopic pores in the construction of his speculum; his own experiments had led him to hope they might be avoided.—Mr. Lassell said, if he had heard Mr. Sollitt correctly, he had said that he used silver in the composition of his speculum metal; now this was a mistake, as he used no silver in its composition. As to the proper proportion of tin to be used with the copper, he believed it to be impossible to give an unvarying rule, as the copper of commerce was very irregular in its quality and purity. He found the best mode to be to add nearly the quantity of tin known to be required,—which generally was from 14 to 15 parts tin, to 32 copper; and then weighing a small portion of that alloy, add to it by slow degrees known weights of tin,—and, assaying it from time to time by the simple test of dropping it into water as soon as it acquired a certain brittleness and brilliancy of fracture, easily to be recognized by practice, then adding in the same proportion to the whole alloy. He did not experience the difficulty from pores which had been alluded to, and he was not aware that Lord Rosse complained of it. His mode of casting most assuredly gave the portion of the speculum which was to be ground and polished free from them.—Mr. Varley said, up to a certain proportion of tin, the brilliancy and perfection of the reflecting power of the alloy seemed to improve, although its brittleness also increased; but beyond a certain limit the tin did not appear any longer to combine with the alloy,—for he has seen it in the process of cooling squeezed out, as it were, leaving the texture of the alloy spongy.

5. *On the Surface Temperature, and Great Currents of the North Atlantic and Northern Oceans*; by the Rev. Dr. Scoresby, (Proc. Brit. Assoc., 1853; Athen., 1098.)—The author commenced by pointing out the great importance to physical geography of the subjects which he proposed to discuss, particularly as they tended, in the economy of nature, to furnish a compensating instrumentality against the extremes of condition to which the fervid action of the vertical sun in the tropical regions, and its inferior and more oblique action in the polar regions, were calculated to reduce the surface of the earth. Our knowledge of

all the currents of the ocean, with perhaps one exception, the Gulf-stream, which had been, in its more important features, carefully examined and surveyed, and more especially in the American Coast Survey,—was derived from the comparison by navigators of the actual position of the ship as determined from time to time with its position as calculated from what sailors technically called the "dead reckoning," or the course steered, and the distance run as determined by the log, an instrument by no means perfect. The determination, however, of oceanic currents, to which the present communication referred, depends simply on induction from observation of temperature, and that mainly of the surface. Such observations, indeed, only become available under considerable differences betwixt the mean atmospheric and oceanic temperatures: and where they may seem to indicate the region from which peculiar qualities of the sea are derived, they can afford but little, if any, information as to the precise direction or strength of the current so indicated, yet still the general results are found important and useful. The researches of the author embrace those in the Greenland Sea, the North Sea, and a considerable belt across the North Atlantic. To those in the North Atlantic he wished at present to direct attention; and to a belt of it embraced within the limits of a series of passages chiefly by sailing vessels between England, or some European port, and New York. Of these passages, sixteen in number, four were performed by the author himself, and twelve were supplied by an American navigator, Capt. J. C. Delano, an accurate scientific observer. The observations on Surface Temperature discussed, amount to 1153, gathered from a total number of about 1400. Usually Capt. Delano recorded six observations each day during the voyage, at intervals of four hours. Seven of the passages were made in the spring of the year,—two in the summer,—one in autumn,—and three in winter. Taking the middle day of each passage, the mean day at sea was found to be May 18th or 19th,—a day fortunately coincident in singular nearness with the probable time of the mean annual oceanic temperature. The author had laid down the tracks of the ship in each of the voyages, on a chart of Mercator's projection, and the principal observations on Surface Temperature were marked in their respective places. The observations were then tabulated for meridians of 2° in breadth, from Cape Clear, longitude 10° W., to the eastern point of Long Island, longitude 72° W., —embracing a belt of the average breadth of 220 miles, or a stretch of about 2,660 miles across the Atlantic. The results were the following: —1. Highest Surface Temperature northward of latitude 40°, 74°; lowest 32°; range 39°.—2. Mean Surface Temperature as derived from the means of each meridional section, 56°, whilst the mean atmospheric temperature for the corresponding period was 54°·2.—3. Range of Surface Temperature within each meridional section of 2°, 8½° at the lowest, being in longitude 20–22° W., and at the greatest 36°, being within the meridian of 62–64° W.—4. Up to longitude 40° the Surface Temperature never descended below 50°;—the average lowest of the sixteen meridional sections being 51°·88, and the average range 11°·3. —5. In the succeeding fifteen sections, where the lowest temperature was 32°, the average lowest was 37°·1 and the average range 29°·7. This remarkable difference in the temperature of the eastern and west-

ern halves of the Atlantic passage, the author said was conclusively indicative of great ocean currents yielding a mean depression of the lowest meridional temperature from 51°·88 to 37°·1, or 14°·8, and producing a mean range of the extreme of temperature on the western side of almost thrice the amount of the extremes on the eastern side,—or, more strictly, in the proportion of 29°·7 to 11°·3. The author drew attention to a diagram in which he had laid down along the entire belt curves showing the whole range of the lowest depressions of temperature and highest elevation, with the means at each longitude distinguished by different shading; and pointed out how the inspection of this as well as of the tabulated results affords striking indications of the two great currents, one descending from the Polar, the other ascending from the Tropical regions, with their characteristic changes of cold and heat. In classifying the results, the author considered the entire belt of the Atlantic track of the passages as divided into six divisions of 10° of longitude each, and these into meridional stripes of 2° each, omitting the first two degrees next the European end, or about 80 miles westward of Ireland to 72° W., or about the same distance west of New York. To each of these six divisions he directed attention, pointing out the conclusions to be derived from each. The curves approaching each other and running nearly parallel through the western half with great regularity, showing the variations and range to be much less, while throughout the eastern half the widening of the distance, and the irregular form of the extreme curves showed the influences of the two currents very remarkably. The author then proceeded to draw conclusions, showing that sometimes the cold current from the north plunged beneath the warmer current from the south. Sometimes they divided,—the colder keeping in shore along the American coast, the other keeping out and forming the main Gulf-stream. Sometimes where they met they interlaced in alternating stripes of hot and cold water; sometimes their meeting caused a deflexion,—as, where one branch of the Gulf-stream was sent down to the south-east of Europe and north of Africa, and another branch sent up past the British Islands to Norway and Scandinavia by the Polar current setting down to the east of Newfoundland. The author next proceeded to consider the uses in the economy of nature of these great oceanic currents. The first that he noticed was the equalizing and ameliorating influence which they exercised on the temperature of many countries. Of this he gave several examples. Thus, our own country, though usually spoken of as a very variable climate, was subject to far less variations of range of temperature than many others in similar latitudes,—which was chiefly from the general influence of the northern branch of the Gulf-stream setting up past these islands. He had himself on one occasion in the month of November, known the temperature to rise no less than 52° in forty-eight hours, —having previously descended in a very few days through a still greater range; while in these countries the extensive range between mean summer and winter temperature scarcely in any instance exceeds 27°, and in many places does not amount to nearly as much. Another advantage derived from these currents was, a reciprocation of the waters of high and low latitudes,—thus tending to preserve a useful equalizing of the saltness of the waters, which otherwise by evaporation in low lati-

tudes would soon become too salt to perform their intended functions. Next he pointed out their use in forming sand-banks, which became highly beneficial as extensive fields for the maintenance of various species of the finny tribes, as in the great banks of Newfoundland. Next, this commingling of the waters of several regions tended to change and renew from time to time the soil of these banks,—which, like manuring and working our fields, was found to be necessary for preserving these extensive pastures for the fish. Lastly, by bringing down from polar regions the enormous masses of ice which, under the name of icebergs, were at times found to be setting down towards tropical regions, they tend at the same time to ameliorate the great heats of these regions, and to prevent the polar regions from becoming blocked up with accumulating mountains of ice, which, but for this provision, would soon be pushed down as extensive glaciers, rendering whole tracts of our temperate zones uninhabitable wilds. Dr. Scoresby concluded by pointing out several meteorological influences of these currents, by causing extensive fogs and winds more or less violent.

6. *On the employment of the higher Sulphids of Calcium as a means of preventing and destroying the Oidium Tuckeri, or Grape Disease;* by Dr. Astley P. Price, (Proc. Brit. Assoc., 1853; Athen. 1100.)—Of the many substances which have been employed to arrest the devastating effects of this disease, none appear to have been so pre-eminently successful as sulphur, whether employed in the state of powder or flowers of sulphur, or by sublimation in houses so affected. Notwithstanding the several methods described for its application to the vines, I am not aware that any had been offered in 1851, when these experiments were instituted, by which sulphur might be uniformly distributed over the branches, and be there deposited in such a manner as to be to some extent firmly attached to the vine. Three houses at Margate, in the vicinity of the one in which the disease first made its appearance in England, having been for the space of five years infected with the disease, and notwithstanding the employment of sulphur as powdered and flowers of sulphur, no abatement in its ravages could be discovered,—I was induced to employ the pentasulphid of calcium, a solution of which having been found to act in no way injuriously to the young and delicate shoots of several plants, was applied to the juices in a dilute condition; the object in view being that the compound should be decomposed by carbonic acid, and that the excess of sulphur should be deposited with the carbonate of lime in a uniform and durable covering on the stems and branches of the vines. This was adopted, and although but few applications were made, the stems became coated with a deposit of sulphur, and the disease gradually but effectually diminished, in so much that the houses are now entirely free from any trace of disease or symptoms of infection. The young shoots are in no way injured by its application, and the older wood covered with this deposit of sulphur continues exceedingly healthy. This was, we believe, the first employment of the higher sulphids of calcium as a vehicle for the application of sulphur to the stems and foliage of diseased vines. Specimens were exhibited from vines which in 1851 were covered with disease, and which have since the autumn of that year received no further treatment. The vines in the imme-

diate neighborhood, and adjoining one of the houses, are covered with the disease, but, notwithstanding their close proximity, no indication of the disease has at present been detected in either of the three houses.

7. *On the Interior of Australia*; by A. PETERMANN, (Proc. Brit. Assoc., 1853; Athen., p. 1168.)—At a time when the exploration of the unknown interior of Australia was earnestly thought of, the probable character of that extensive region became a subject of particular interest, and of legitimate inquiry. Scarcely one-third part of Australia could be said to have been even partially explored, and by far the larger portion was therefore entirely unknown. This unknown interior of Australia had frequently been a matter of speculation, at first founded on very few facts. But, as our knowledge increased, and actual facts became more numerous, the theories had been modified. One of these hypothesis was, that the interior, to a certain extent, consisted of a shoal sea. It was in 1814, only forty years since, when the exploration of inner Australia might be said to have been systematically commenced, that Mr. Oxley, the first surveyor-general of New South Wales, a man of acknowledged ability and merit, surrounded about one-eighth part of the longitudinal extent of Australia. By tracing down the rivers Lachlan and Macquarie, he was checked in his progress westward by marshes of great extent, beyond which he could not see any land. He was, therefore, led to infer that the interior was occupied by a shoal sea, of which the marshes were the borders, and into which the rivers he had been tracing discharged themselves. The probability of this opinion was supported by the fact that the mouth of the largest of the Australian rivers, the Murray, had been overlooked by Capt. Flinders, and was not discovered till fifteen years after Mr. Oxley's discoveries, by Capt. Sturt. This opinion was adopted by subsequent travellers. In 1845, Mr. Eyre, one of the most distinguished explorers of Australia, in a paper communicated to the Royal Geographical Society, announced that he had arrived at different conclusions, namely, that the interior would be found generally to be of a very low level, consisting of sand, alternating with many basins of dried salt lakes, or such as were covered only by shallow salt water or mud, as was the case with Lake Torrens. He also said that it was more than probable there might be many detached and even high ranges, similar to the Gawler Range, and that, interspersed among these ranges, intervals of a better or even of a rich and fertile country, might be met with. In 1850, Mr. J. B. Jukes, in his valuable work on "The Physical Condition of Australia," stated his opinion to be that the interior consisted of immense desert plains, which seemed to extend to the sea coast round the Gulf of Carpentaria, or north to that of the Great Australian Bight on the south, and to stretch along the northwest coast to Collier Bay. The general opinion at present entertained on this point seemed to be very similar to that of Mr. Jukes, excepting, perhaps, that it was thought that the deserts did not reach so far to the north, and the northern parts were considered to consist of some fertile and promising regions. The chief grounds on which these deductions have been made were the known facts as to the climate and meteorology of Australia, and the absence of large rivers, besides other features. It was well known that the Australian colonies were subject in summer to occasional blasts of what is called the hot-wind, from its ex-

tremely high temperature. This hot wind always blew from the interior, in New South Wales and Tasmania, its direction being from the northwest and from the north in Port Phillip and South Australia. The breath of this wind was like the blast from a fiery furnace, increasing the mean temperature of a summer's day, on the westerly side of the eastern Cordillera, to 40°: on the eastern side, both in New South Wales and Tasmania, to 25° and 30°; and while during the hot wind the thermometer rose to 100° or even 115° in the shade, with the southerly squall there was sometimes a sudden fall of full 40° in the course of half or even quarter of an hour. This wind swept up from the interior clouds of dust and sand, sometimes intermixed with gritty matter large enough to strike with painful acuteness on the face. Count Strzelecki, while sailing from New Zealand to New South Wales, was prevented from making the harbor of Port Jackson for two successive days, by the violence of this hot wind. Though sixty miles from the shore, the heat exceeded 90°, and the sails of the ship were covered with a small powder by the breeze. The hot winds were, indeed, identical with the sirocco blowing from the great Sahara of Africa, and similar winds in other parts of the globe. It had been justly said that these hot winds, experienced in the southern parts of Australia, could have no other origin than by a current of air blowing over some large expanse of burning desert, and our knowledge of the adjoining regions entirely corroborated this assumption. The discoveries of Capt. Sturt, in his last expedition in particular, indicated the very nest and hot-bed of the winds. The situation of Capt. Sturt's desert was such that there was good reason to think its influences would extend to the whole of the coasts, even to those of Western Australia, which were the farthest from it, namely, about 1,350 geographical miles; unless the winds blowing from it were intercepted or deflected in the intervening spaces by mountains, or else ameliorated by countries of different character. The influence of the hot winds from the Sahara had been observed in vessels traversing the Atlantic at a distance of upwards of 1,100 geographical miles from the African shores by the coating of impalpable dust upon the sails. Mr. Petermann proceeded to describe the results of his investigations with respect to the causes of the hot winds, and observed that the heat of the winds in southern and eastern Australia was far more intense than in the north-eastern parts. He then remarked that he believed a great part of the interior of Australia to consist of sterile deserts; that the Torrens Basin and Sturt's Stony Desert formed the centre of the largest of these deserts, which probably extended from 200 to 300 miles around the latter, and that a fringe of 200 to 300 miles extended all along the great Australian bight to Western Australia, and along the western coasts as far as the Gascoyne Basin, or even the river Fitzroy. It also appeared to him that the whole of northwest Australia, north of Fitzroy River, as far as the head of Carpentaria Gulf, was a region of the most promising character, and that from this region a spur of more or less elevated land extended as far as the cluster of mountains discovered by Sir Thomas Mitchell, and which gave birth to many beautiful rivers flowing in all directions of the compass. This spur would necessarily form a bar between Sturt's desert and the Gulf of Carpentaria. It seemed to him most probable that this

promising district of northwest Australia extended far to the south, to the middle of the continent, and beyond it, at least to the latitude of Gascoyne River. One significant fact supported the latter opinion, and that was the occurrence of large trees which had been floated down the rivers of northwest Australia, and found at their mouths,—an occurrence unknown in southwestern Australia. In conclusion, Mr. Petermann said he could not but hope that a portion of this extensive and promising district would be explored and laid open for the benefit of mankind.'

8. *On Preserving the Balance between Vegetable and Animal Organisms in Sea-water*; by R. Warrington, (Proc. Brit. Assoc., 1853; Athen., 1166.)—The public were first indebted to Mr. Warrington for a statement of the conditions in which animals could be kept in fresh-water without changing the water. It is not sufficient that there should be plants alone; but where the higher animals such as fish are kept, it is necessary that some beings should exist which will feed on the decaying vegetable matter. This desideratum is supplied by the various forms of phytophagous Mollusca. The author's success with fresh-water led him to try experiments with sea-water, and the results of his investigations were given in this paper. The most important fact established was, that marine animals could be kept in sea-water without changing in the same manner as in fresh. The conditions of the existence of sea-water creatures are, however, much more varied than those of fresh; hence the difficulty had been proportionally great in arriving at a successful issue. The nature of the plants in the first place is a matter of importance. The author found that the green sea-weeds answered better than the red or brown. In introducing animals they should be healthy and uninjured. Those should not be put together which devour each other. Crabs, especially the common crab, are very destructive; so are gobies, blennies, and rock-fish. The sea-water should be kept of a proper gravity. It should be 1·026 at a temperature of 60°. Rain or distilled water should be added from time to time to supply any loss. All dead animal or vegetable matter of any kind should be removed.

Dr. Daubeny stated that he had erected some fresh-water tanks at Oxford; but the difficulty which he had to contend with was the growth of Confervæ, which interrupted the growth of the other plants.—Dr. Walker-Arnott stated that he had no doubt the reason why the green sea-weeds answered better than the brown or red was that the latter were deep sea, whilst the others were shallow water, plants. The brown and red sea-weeds also had a much denser tissue externally than the green sea-weeds, and did not grow so fast.

9. *Appendix to the History of Vermont*; by Zadock Thompson. 64 pp. 12mo, with a map. Burlington, 1853.—This Appendix to Mr. Thompson's Vermont, is devoted to its Natural History, Geology, Meteorology and surface Features, in which departments it contains considerable original information. Among the discoveries of the author are the bones of the elephant, and of a new fossil whale. The latter is named by Mr. Thompson the Beluga vermontana, (this Jour., [2] ix, 256.) We cite the following altitudes of different places in Vermont, from page 6:—

ALTITUDES ABOVE THE OCEAN.

Mountain Summits.

		Feet.
Chin, *Mansfield,*	*Thompson,*	4348
Nose, "	"	4044
South Peak, "	"	3882
Camel's Hump, Duxbury, "		4083
Jay Peak,	*Adams,*	4018
Shrewsbury Peak,		4086
Killington, " Sherburne,	*Partridge,*	3924
Equinox, Manchester,	"	3706
Ascutney, Windsor,	"	3320
Snake Mt., Bridport,	*Adams,*	1310
Buck Mt., Waltham,	"	1035
Sugar Loaf, Charlotte,	*Thompson,*	1003
Snake Hill, Milton,	"	912
Cobble, "	"	827

Passes over the Green Mountains.

Lincoln,	*Adams,*	2115
Granville,	"	2340
Peru,	"	2115
Sherburne,	*Partridge,*	1882
Walden,	*De Witt Clinton,*	1615
Mt. Holly, (R. Road)	*Gilbert,*	1415
Roxbury, (R. Road)		997
Williamstown,	*Johnson,*	908

Villages.

Burlington Town House,	*Benedict,*	202
" University,	"	367
Milton Falls,	*Thompson,*	298
Essex,	"	452
Jericho Corners,	"	604
Underhill Flat,	"	665
Williston,	"	402
Franklin,	"	430
St. Albans,	"	370
Highgate Springs,		160
Swanton,		160
E. Berkshire,		460
Winooski Falls,		203
Sheldon,		375
Richmond,		332
Waterbury,		425
Middlesex,		520
Montpelier, (Capitol,)		540
Northfield, (Depot,)		724
Braintree,		732
West Randolph,		678
Bethel,		556
Royalton,		476
White River Junction,		335
Windsor,		288
Bellows Falls,		225

	Feet.
Woodstock,	400
Brattleborough,	160
Bennington,	432
Manchester,	650
Rutland,	500
Castleton,	475
Ludlow,	985
Proctorsville,	895
Chester,	670
Brandon,	460
Middlebury,	390
Vergennes,	225
Norwich,	400
Newbury,	420
Barnet,	460
St. Johnsbury,	585
Lyndon,	735
Barton,	953
Derby Centre,	975
" Line,	1050
Craftsbury Common,	1158
Troy, South,	740
Irasburgh,	875
Hardwick Hollow,	720
Hydepark,	560
Cambridge,	410
Johnson,	460

Lakes and Ponds.

Champlain Lake,*		90
Memphremagog "		695
Joe's Pond,	Cabot,	1544
Lyford's Pond,	Walden,	1692
Molley's Pond,	Cabot,	1626
Winooski Pond,	Peacham,	1410
Wells River Pond,	Groton,	1060
Crystal Pond,	Barton,	933
Mud Pond,	Sutton,	1183
Savanna Pond,	"	1210
Willoughby Lake,	Westmore,	1161
Elligo Pond,	Craftsbury,	893
Salem Pond,	Salem,	967
Pensioners Pond,	Charleston,	1140
Island Pond,	Brighton,	1182
Lake Connecticut, head of Con. River, in N. H.,		1589

Falls.

Great Falls, Marshfield, (head,)	1074
" " (foot,)	871
Nat. Bridge Falls, Waterbury (foot,)	345
McIndoe's Falls, Barnet, (head,)	449
" " " (foot,)	436
20 Miles Rapids, Lunenburg, (head,)	822
" " Barnet, (foot,)	486
Guildhall Fall, Guildhall, (head,)	835

* The level of Lake Champlain is taken for a basis in many of the surveys, which have been made, for canals and railroads, and their profiles indicate the height of places above the lake. In estimating, from these, the heights above the ocean, for the accompanying tables, 90 feet are added. The mean height of the lake above the ocean is frequently stated at 94 or 95 feet, but from the data, to which I have had access, I am disposed to think that 90 feet is nearly the true height. The change of level of the lake, that is, the difference between the extreme high water and the extreme low water marks, amounts to eight feet.

10. *On an Aurora Borealis of September 2nd*, 1853; by M. H. Boye.—I observed this aurora on the 2d of September last (1853) when on the Newfoundland Bank, about 10 miles south and 26 miles west of Cape Race, or in latitude 46° 25′ to 30′, and longitude 53° 25′ to 35′ (Greenwich). The previous evening an inconsiderable aurora had occurred soon after sunset, consisting of luminous clouds with few occasional streamers. On this occasion (the 2d of Sept.) the aurora commenced in the same manner not long after sunset, with luminous places and occasional streamers on the northern hemisphere, and also some on the east side of the southern hemisphere. Afterwards it assumed the appearance of three distinct arches of light, with their convex side upward; one in the N. W., being a kind of double arch, or having an undulation; a second of smaller size in east of north; and a third very large one beginning on the eastern side of the southern hemisphere, and gradually extending towards the western part of it embracing between its feet from one-third to nearly one-half of the whole horizon. The space below it was dark and without streamers, giving the appearance of limiting a cloud, but this could not be, as the stars were distinctly visible below it. From its upper convex edge, streamers would shoot up emerging towards a point below the zenith, in the southern hemisphere.

The space of radiant light, or corona, formed and disappeared many times, being most perfect at or about 9h. to 9h. 15 min. P. M. At the same time streamers would shoot up from all the arches, and in fact from every part of the heavens towards or quite to the radiant space. These appearances were repeated at very frequent intervals for more than two hours, from 8 to 10 o'clock. At times, and particularly towards the close of the phenomenon, the long streamers became more indistinct, and resolved themselves into innumerable dispersed lines of light terminating at their lower extremity, in a small bunch of short lines, giving the appearance of a golden rain or a golden figured drapery all over the heavens, which latter seemed to be illuminated on all sides. Altogether I consider it one of the finest auroras ever noticed, and particularly as regards the splendor and fullness of the light in the radiant space or corona, the sudden formation of which reminded me involuntarily of the sudden formation of crystals. The light of this aurora exhibited but a slight variation in colors, and there was some, but not much lateral motion of the streamers. Capt. Leitch of the steamer informed me, that he had been unable to observe any effect on the magnetic needle, the variation of which in this place he gave as 27° west, and which, as he paid particular attention to it, he would hardly have failed to do, had the effect amounted to 2° or 3°.

I have been informed, by several gentleman, that on the same evening an aurora was visible in Philadelphia, consisting of a band of light.

11. *On the Popular Theory of an Arctic Basin. Is it true?* by the Rev. Dr. Scoresby, (Proc. Brit. Assoc., 1853; Athen., 1167.)—The reverend gentleman proceeded to refute the notion of an Arctic basin, and observed that he was fully convinced of the futility of attempting to reach the North Pole by water. He believed he had penetrated farther into the Arctic Regions than any living man in the world—namely, to a

distance of 80½ degrees,—and his observations had left no doubt in his own mind that the country about the North Pole was one mass of stupendous blocks of ice. This opinion, he knew, was not by any means the popular one; but still he had not made his assertion without some claim to knowledge on the subject, and he would stake whatever reputation he might have as a traveller in those parts on the correctness of his statement. He firmly believed, however, that the North Pole might be reached by land, and in 1815 he had expressed that opinion in a work which he then published. In Edinburgh that opinion had been well received, but in England it was ridiculed as a wild and preposterous notion. Since then, Capt. Penny had undertaken an expedition on his plan, and though he had failed in the object of his mission, it was owing to circumstances over which he had no control. He (Dr. Scoresby) still thought the Pole might be reached. But by water it was, as he had said before, wholly impracticable.

A discussion ensued, in which Mr. Findlay and Dr. Shaw took part; the latter, after directing attention to the Arctic discoveries of Commander Inglefield, asserted his belief that it was by sea and not by land that a Polar basin is to be sought. The deeper the water the less ice is to be expected,—and a screw yacht might start from England in May, and return home in October with an account of a further penetration to the northeast between Spitzbergen and Nova Zembla than had as yet ever been accomplished by any navigator.

12. *On the Consolidation of Coral Formations.*—The paper by Prof. Horsford referred to on page 357, has recently appeared in a pamphlet form, and a copy has been received by the writer from the author. The paragraphs from Prof. Horsford's paper cited in my article in this number and the other statements referred to by me, remain in the pamphlet as they were published in the Traveller.—J. D. D.

13. *Daguerreotypes for the Stereoscope.*—The daguerreotype sent us by Prof. Barnard, as mentioned on page 350, is a very beautiful specimen of the art, besides having the peculiar interest which adapts it for the stereoscope. There are two admirable pictures, on the same plate, at the requisite distance apart for an ordinary stereoscope.

14. *British Association.*—The twenty-third meeting of the British Association was held at Hull during the week from the 7th of September last. The meeting for 1854 was appointed to be held at Liverpool.

15. *Clinochlore.*—The crystal of Clinochlore figured on page 436, vol. xv, of this Journal, was from the cabinet of William W. Jefferis of Westchester, Pennsylvania.

16. *Arago.*—The celebrated philosopher, Arago, died at Paris on the evening of Sunday the second of October. His age was 67 years, having been born February 26, 1786, at Estagel in the south of France.

17. *H. E. Strickland.*—We have to announce, with deep regret, the death of Mr. H. E. Strickland, who was killed on Wednesday by a railway train, whilst examining the strata of a railway cutting on the Manchester, Sheffield, and Lincolnshire line. The melancholy particulars are thus given in the daily papers.—"Mr. Strickland arrived at East Retford on Wednesday from Hull, having attended the recent meeting of the British Association. He was attached to the Geological Section of the Association; and in pursuance of his practical investigations in

that science, he proceeded on Wednesday afternoon to examine the strata of the deep cuttings on each side of the Clarbrough Tunnel, about four miles distant from Retford. A little after four o'clock, a boy at work in the fields observed him standing between the two lines of rails, near the mouth of the tunnel, on the Gainsborough side, with a pocket-book in his hand, apparently engaged in making notes. At this time, a coal train was approaching on the down line,—to avoid which, he stepped off the 'six feet' on to the up-line;—but unhappily he did so just at the moment when the Great Northern passenger train was issuing from the tunnel. The train dashed upon him,—and the next instant he lay a shattered and shapeless corpse."

Mr. Strickland was in the prime of life,—at that age when the promise of youth is fast realizing itself. He was born at Righton, in the East Riding of Yorkshire, on the 2nd of March, 1811. His father, Mr. Henry E. Strickland, of Apperley, in Gloucestershire, was a son of the late Sir George Strickland, Bart., of Boynton, in Yorkshire. He was a grandson on his mother's side of the celebrated Dr. Edmund Cartwright,—whose name is so indissolubly connected with the manufacturing greatness of England on account of his invention of the power-loom.

Mr. Strickland's boyhood was spent under his father's roof; where he was under the private tutelage successively of the three brothers Monkhouse,—one of whom is now a Fellow of Queen's College, Oxford. From his father's house he was transferred to the late Dr. Arnold,—who, prior to his appointment at Rugby, took private pupils at Laleham, near Staines. He finished his education at Oriel College, Oxford.

Although distinguished for his classical knowledge, Mr. Strickland had early acquired a taste for natural history pursuits; and after the completion of his studies at college he resided with his family at Cracourt House, near Evesham, Worcestershire—where he studied minutely the geology of the Cotswolds and the Great Valley of the Severn. Some of his earliest published papers were on geology; but his first effort as an author indicated a taste for the pursuits of his maternal grandfather. It appeared in the *Mechanics' Magazine* for 1825,—and was on the construction of a new wind-gauge.

In 1835, Mr. Strickland travelled in Asia Minor, in company with Mr. W. J. Hamilton, M.P.,—who was then secretary to the Geological Society. An account of this journey was published, in two volumes 8vo., by Mr. Hamilton, 1842, under the title "Researches in Asia Minor, Pontus and Armenia." This tour resulted also in the publication of several interesting papers on the geology of the districts visited, both by Mr. Strickland himself and conjointly with Mr. Hamilton. The principal papers published by Mr. Strickland singly were—"On the Geology of the Thracian Bosphorus."—"On the Geology of the neighborhood of Smyrna."—and "On the Geology of the Island of Zante." He early devoted his attention to the study of birds; and during this journey he gave proof of his ornithological knowledge by adding to the list of birds inhabiting Europe the *Salicaria Oliveiorum*. He subsequently devoted a large share of his attention to the study of birds:—as his papers in the "Annals and Magazine of Natural History," and

Sir William Jardine's "Contributions to Ornithology" amply testify. His principal work, however, on this subject, and the one which will give him a place amongst the classical writers on the ornithology of this country, is devoted to the history of the Dodo. * *

Although as a zoologist, ornithology was his strong point, Mr. Strickland had an extensive knowledge of the various classes of organized beings. Thus, several of his papers were devoted to accounts of the Mollusca, both recent and fossil, in various districts. One of his papers at the last meeting of the British Association at Hull was, as our readers will see elsewhere, "On the Peculiarities of a Form of Sponge (*Halichondria saberea.*")

Mr. Strickland paid a large share of attention to the terminology of natural history,—and was the reporter of a Committee appointed by the British Association to consider of the rules by which the nomenclature of zoology might be established on a uniform and permanent basis. These rules were principally drawn up by him; and they have since their publication been very generally acted on,—and have contributed greatly to simplify Natural History nomenclature.

The general principles of classification could hardly fail to interest a mind so discursive as his,—and, accordingly, we find him at various times publishing on this subject. * *

It must be obvious, that the labors to which we have alluded imply an immense amount of industry,—but in the midst of all his practical investigations Mr. Strickland found time for purely literary work. Thus in 1847, he undertook to edit for the Ray Society a work, the collection of materials for which had cost Prof. Agassiz many years of labor, entitled "Bibliographia Zoologiæ et Geologiæ." Three volumes of this great work are published,—and the fourth and last is now in the hands of the printer. Mr. Strickland's labor here was not merely that of editing—it embraced the contribution of a large mass of additional matter, amounting to a third or a fourth of the whole. * *

On the occurrence of the illness of Dr. Buckland, and his withdrawal from the duties of the chair of geology at Oxford,—every one felt the propriety of inviting Mr. Strickland to deliver lectures in his place. Though young for so important a post, and with a reputation in other departments of science, he was found able to sustain the fame of his predecessor in this,—and brought to bear with great advantage the stores of his varied knowledge upon a science which is always susceptible of influence and amplification from the principles of other departments of science, however, distant from it they may at first sight appear.—The Reports of the British Association, the Transactions of the Geological Society, the papers of the Quarterly Journal of the Geological Society of London, and of the London and Edinburgh Philosophical Magazine, all testify to Mr. Strickland's activity as a geologist.

In several of the geological papers, Mr. Strickland's name is connected with that of Sir R. I. Murchison:—especially in a work on "The Geology of Cheltenham and its neighborhood." He assisted Sir Roderick in preparing for the press his great work on the Silurian system; and the proof-sheets of his new work on Siluria all passed through Mr. Strickland's hands,—the last of the work having been corrected at Hull.

In 1845, Mr. Strickland was married to the second daughter of Sir William Jardine, Bart. :—both of whom, with Mr. Strickland's father and mother, survive to lament his premature loss.

In the above brief sketch we have spoken only of Mr. Strickland's scientific career, but he had moral qualities that endeared him to all who knew him. Few came in contact with him who did not recognize in him a conscientious, amiable, and excellent man. In him Oxford has lost a Professor whom she could ill afford to part with at this time. To him, they who hoped for the wider culture of natural science at Oxford looked as to one who had the power and the ability to take the lead. The scientific societies have lost in him a member who was unwearied in his assiduity to carry out their objects in all their purity. His means made him independent of his labors ;—and all recognized in his exertions that love of science and its objects which constitutes the true philosopher.—*Athen.*, 1853, pp. 1094, 1125.

18. *Annual Report of the Superintendant of the Coast Survey ;* showing the Progress of that work during the year ending November, 1851.—We allude again to this Report on the Coast Survey under Prof. Bache, to express our pleasure in the improved style in which it has been issued. It is a document of great value, in a scientific point of view, and deserves good paper, type, and binding, and these it now has. The valuable series of plates and sketches, instead of being folded into the octavo report make a 4to volume of themselves, which is convenient both for use and for their preservation.

19. *Twentieth Annual Report of the Royal Cornwall Polytechnic Society*, 1852. 108 pp., with tables. *Falmouth.*—Contains catalogues of plants and animals found at Falmouth, by W. P. Cocks, Esq. ; observations on the Harvest in the east part of Cornwall, from 1816 to 1852, by J. Couch, Esq. : and an Essay on the China Stone and China Clays of Cornwall, with a description of some Mechanical Improvements in the mode of preparation of the latter, by Mr. H. M. Stoker.

20. *The Book of Nature ;* an elementary introduction to the sciences of Physics, Astronomy, Chemistry, Mineralogy, Geology, Botany, Zoology and Physiology ; by Friedrich Schoedler, Ph. D., Prof. Nat. Sci., at Worms, etc. 1st Amer. Edit. with a glossary and other additions and improvements from the second English edition, translated from the sixth German edition, by Henry Medlock, F.C.S., director of the Marlborough Street Laboratory and School of Practical Chemistry, etc. 692 pp. 12mo., illustrated by 697 engravings on wood. *Philadelphia*, 1853 ; Blanchard and Lea.—This volume, as its title shows, covers nearly all the sciences, and embodies a vast amount of information adapted for instruction. No other work that we have seen presents the reader with so wide a range of elementary knowledge, with so full illustrations, at so cheap a rate.

21. *The Ethnographical Library, conducted by* Edwin Morris, Esq. Vol. I. *The Native Races of the Indian Archipelago, Papuans ;* by George Windsor Earl, M.R.A.S. 240 pp. 8vo. *London*, 1853, H. Bailliere.—Mr. Earl is well known as a writer on the Indian Archipelago and Australia. In this volume he treats of the Papuans of the East Indian Islands, describing their features, tribes, manners, social conditions, and implements, and various incidents in their history

since known to the whites, besides discussing to some extent the resources of the countries they inhabit. The work is illustrated by maps, and by sketches on stone of the natives, part of which are colored. The subject is to a considerable extent a novel one, and abounds in details of interest to the general reader as well as the ethnographer.

22. *Contributions to the Physical Geography of South Eastern Asia and Australia;* by G. W. EARL. 48 pp. 8vo., with a map. From the Journal of the Indian Archipelago, for May 1852. London, H. Bailliere.—The author briefly describes the general features and structure of some of the East India Islands, and their changes of level, but without many details by way of evidence, or a full display of precise facts in illustration of his subjects.

23. *Report of Progress of the Geological Survey of Illinois;* by J. G. NORWOOD, Geologist; communicated to the Illinois Legislature, at the session in 1853. 13 pp. 8vo., 1853.—This report announces the commencement of a Geological Survey of Illinois. The investigations promise to be well carried out under the direction and labors of Mr. Norwood. The state abounds in mineral products of economical value, as beds of iron, coal, mines of lead, building stones, etc. Its fossil remains are in vast numbers, and of high interest, and already rich collections have been made.

24. *American Handbook of the Daguerreotype*, giving the most approved and convenient methods for preparing the chemicals and the combinations used in the Art, and containing the Daguerreotype, Electrotype, and various other processes employed in taking Heliographic Impressions; by S. D. HUMPHREY. 110 pp. 12mo. *New York*, 1853.—Much practical information is embraced in this little work and it will be valued by those interested in the art of which it treats. Some of the chemistry however requires a revision.

JOURNAL OF THE UNITED STATES AGRICULTURAL SOCIETY; Published Quarterly. No. 1. July, 1853. 160 pp., 8vo. *Philadelphia*, 1853.

THE PEOPLE'S MEDICAL GAZETTE; edited by John Davis, M.D., Practising Physician. Published monthly, $1.00 per annum. Vol. I, No. 1, September, 1853, pp. 32.

THE AMERICAN COTTON PLANTER; A Monthly Journal devoted to Improved Plantation Economy, Manufactures, and the Mechanic Arts; edited by N. B. Cloud, M.D., La Place, Alabama: begun with January, 1853, and issued monthly at $1 per year.

THE MEDICAL REPORTER; A Quarterly Journal published under the direction of the Chester and Delaware County Medical Society, Pennsylvania. No. 1. September, 1853. 32 pp. 8vo. $1 per annum.

REPORT OF BRITISH ASSOCIATION for 1852. *London*, 1853.

THEODOR FISCHER of Cassel, Germany.—The large number of expensively illustrated scientific works published by Mr. T. Fischer, leads us to mention his name in this place. Among the works issued by him are the following:—Dunker and von Meyer's Palæontographica; W. O. Weber's Tertiärflora der niederrheinischen Braunkohlenformation; Göppert's Beiträge zur Tertiärflora Schlesiens; A. F. Römer's Beit. zur geol. Kenntniss des nordw. Harzgebirges: F. v. Hagenow's Bryozoen der Maastrichter Kreidebildung; R. A. Philippi's Conchylien, with 144 pl; ib. Neue Land- und Susswasserconchylien, with 44 pl.; ib. Neue See Conchylien, with 100 pl.; Hermannsen's Indices Generum Malacozoorum Primordia; L. Pfeiffer's Symbolæ ad Histor. Heliceorum; Menke u. Pfeiffer's Zeits. f. Malacozoologie; L. Pfeiffer's Bluhender Cacteen; ib. Monographia Pneumonoponorum viventium, etc.

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